REFINER

Hanlon-Buchanan, Inc

PIONEER NATURAL GASOLINE MANUFACTURER

EXPORT TERMINALS:
Goodhope, La. Corpus Christi, Tex.
Houston, Texas Texas City, Texas
Baytown, Texas

TULSA, OKLAHOMA
NATIONAL BANK OF TULSA BUILDING
Phone 2-3181 Wire or Write P. O. Box 1359
Cable Address "STANOLENE" Tulsa, U. S. A.

FOREIGN REPRESENTATIVE
Anglo-American Oil Co., Ltd.
St. James's House
London, England

DELIVERY!

RE: ARCOS CHROMANG ELECTRODES FOR WELDING ARMOR

ARCOS gives only firm delivery dates because each Arcos promise is based upon carefully scheduled production. When you order Chromang you receive your electrodes on time.

ARCOS CORPORATION
401 N. Broad St., Phila., Pa.

ARMY NAVY

it's ARCOS for stainless electrodes

"QUALITY WELD METAL EASILY DEPOSITED"

Distributors Warehouse Stocks in the Following Cities:

BUFFALO, N. Y.	*Root, Neal & Co.*
BORGER, TEXAS	*Hart Industrial Supply Co.*
BOSTON, MASS. (Belmont)	*H. Boker & Co., Inc.; W. E. Fluke*
CHICAGO, ILL.	*Machinery & Welder Corp.*
CINCINNATI, OHIO	*Williams & Co., Inc.*
CLEVELAND, OHIO	*Williams & Co., Inc.*
COLUMBUS, OHIO	*Williams & Co., Inc.*
DETROIT, MICHIGAN	*C. E. Phillips & Co., Inc.*
ERIE, PENNA.	*Boyd Welding Co.*
FRESNO, CALIF.	*Victor Equipment Co.*
FT. WAYNE, IND.	*Wayne Welding Supply Co., Inc.*
HONOLULU, HAWAII	*Hawaiian Gas Products, Ltd.*
HOUSTON, TEXAS	*Champion Rivet Co. of Texas*
KANSAS CITY, MO.	*Welders Supply & Repair Co.*
KINGSPORT, TENN.	*Slip-Not Belting Corp.*
LOS ANGELES, CALIF.	*Victor Equipment Co.*
MILWAUKEE, WIS.	*Machinery & Welder Corp.*
MOLINE, ILL.	*Machinery & Welder Corp.*
NEW YORK, N. Y.	*H. Boker & Co., Inc.*
OKLAHOMA CITY, OKLA.	*Hart Industrial Supply Co.*
PAMPA, TEXAS	*Hart Industrial Supply Co.*
PITTSBURGH, PA.	*Williams & Co., Inc.*
ROCHESTER, N. Y.	*Welding Supply Co.*
SAN FRANCISCO, CALIF.	*Victor Equipment Co.*
SEATTLE, WASH.	*Victor Equipment Co.*
ST. LOUIS, MO.	*Machinery & Welder Corp.*
SYRACUSE, N. Y.	*Welding Supply Co.*
WICHITA, KANSAS	*Watkins, Inc.*

R.G

PETROLEUM REFINER

SPECIALIZED FOR THE OIL REFINING INDUSTRY, INCLUDING PETRO-CHEMICAL ENGINEERING, PETROLEUM SYNTHETICS AND NATURAL GASOLINE

JANUARY, 1943
Vol. 22, No. 1

A Gulf Publishing Company Publication
EDITED MONTHLY AT HOUSTON, TEXAS

GRADY TRIPLETT
Editor

Copyright, 1943

CONTENTS

Sulphur Compounds from Panuco Gasoline 61
Walter Freidmann and Cesar Canseco

What Takes Place in Thermal Cracking 66
Paul H. Faust

Emergency Use of Oil-Coal Suspensions as Colloidal Fuel 69
W. L. Faith and H. W. Zabel

X-Ray Analysis and Chemical Scale Removal 72
S. C. Morian

Low Temperature Characteristics of Greases 76
Thomas A. Maxwell

Vapor Pressure Chart for Volatile Hydrocarbons 79
R. Vincent Smith

Effect of High Pressure Extrusion on the Absorption Capacity of Floridin 82
R. C. Amero and R. G. Capell

An Application of Arc Welding in the Maintenance of Heat Transfer Equipment 87
W. H. Parlette

Fractionating Tower Fabricated from Tank Steel 90
Elton Sterrett

America's Foundation Stone 94
J. Howard Pew

Liquefied Petroleum Gas in 1942 100
G. G. Oberfell

PIWC Sees Crude Requirement Up 400,000 Barrels During 1943 112

Departments

Look Box ..... 59 and 109

Science and Technology 128

New Equipment 144

Business Notes 152

Catalogs and Bulletins 155

Advertisers' Index 158

CENSORSHIP NOTICE—Censorship rules occasionally make it necessary to tear out or otherwise delete part of publications destined to subscribers outside the United States. If there be such deletions in copies of REFINER going abroad, they are at the request of the Office of Censorship. Copies sent abroad face unavoidable delay because of time necessarily consumed in passing the publication through the Office of Censorship.
—The Publisher.

SPECIALIZED OIL JOURNALS

Published by

THE GULF PUBLISHING COMPANY

OFFICE OF PUBLICATION

3301 Buffalo Drive, Houston, Texas

R. L. DUDLEY, *President*

A. L. BURNS, *General Manager*

S. W. ROBINSON, *Editorial Director*

J. KENT RIDLEY, *Managing Editor*

TOM W. NELSON, *Advertising Manager*

NEW YORK: Room 625, 250 Park Avenue, Dick Swinsky, Manager.

PITTSBURGH: 429 Fourth Avenue, Chas. A. Wardley, Manager.

CHICAGO: 332 S. Michigan Avenue, H. G. Fitzpatrick, Manager.

LOS ANGELES: 425 W. W. Wilson Building, Huntington Park, California, Jay Curtis, Jr., Manager.

TULSA: 1304 Hunt Building, J. F. Carter, Jr., Manager.

FT. WORTH: 203 W. T. Waggoner Building, H. H. King, Manager.

Single copies 20 cents (except special issues). Subscription price, domestic and foreign, $2.00 a year; 2 years $3.00. Entered as second class matter June 16, 1923, at the post office at Houston, Texas, under act of March 3, 1879.

Advertising rates on application. Copyright 1943 by The Gulf Publishing Company.

What is in the Package besides Smith Welding

MILD STEEL...HIGH TENSILE
AND STAINLESS STEEL
ELECTRODES

Made by welders
for welders

VOLUME 22, NO. 1 JANUARY, 1943

PETROLEUM
REFINER

SPECIALIZED FOR THE OIL REFINING INDUSTRY, INCLUDING PETRO-CHEMICAL ENGINEERING, PETROLEUM SYNTHETICS AND NATURAL GASOLINE

A GULF PUBLISHING COMPANY PUBLICATION

THE LOOK BOX

BUNGLING continues in synthetic rubber. For all the encouragement the work of the Baruch committee brought the plant-building program is still behind schedule and there is evidence of bickering between agencies in Washington.

Bungling Continues

Both William M. Jeffers, director of the rubber program, and Colonel Bradley Dewey, the deputy director, have in statements and in testimony expressed the fear that delay in plant construction will leave crude-rubber reserves dangerously low in the second half of 1943. Their expressions leave no doubt that plants are not progressing according to schedule.

One phase of the report of the Baruch committee about which there could be no disagreement was its insistence that plants be built as then planned and on schedule. This report branded delay as disastrous.

Why and how the construction program has since been delayed are questions not answered yet and it is to be hoped that some other committee will not be required to find the answers. One intimation in the way of answer is the conflict between capacity for 100-octane-aviation gasoline and butadiene. Evidently men in authority find it difficult to decide which shall be first. It is a confusing question, the reverse of that concerning which was first—the hen or the egg. Without the motor fuel there will not be great military need for rubber; without rubber to line the airplane's fuel tank and pad its wheels there will be scant need for 100-octane motor fuel.

Some man of wisdom and courage should be quickly given the task of dividing each ton of steel that is allotted to refining. Unless that steel is properly divided the folly of waiting to see what would happen to Singapore will be repeated in waiting to see which petroleum product should come first.

Controversy was unavoidable in the early stages of the rubber program. Three agencies of government were involved. One had money, one had processes, one had materials. Then each added technical experts and the stalemate was little short of perfect.

The Baruch committee singled out this cause for delay and asked for a single responsibility, which came into existence.

Still there is evidence of bickering in Washington. Only last month Defense Plant Corporation made public a list of 67 contracts it has made for construction of that many plants within the synthetic rubber program. Along with details the report carried this cryptic line:

"These arrangements were made prior to the appointment of the Rubber Director [Jeffers]."

Self praise has no place in the synthetic-rubber program. The whole project has been so poorly handled as to bring discredit to official Washington and to the industries involved. Even petroleum refining had a spell of process argument when all its attention should have been centered on plant building. When a farm block senator raises the issue between oil and grain as the source material for butadiene, he has contributed nothing but delay. The military machine needs all the

butadiene that can be produced regardless of source.

This nation may face other situations as critical as that of rubber. If so, it is to be hoped that the solutions are not so muddled.

Turn About

IT DOES not seem consistent, still it could be, that the Japs are striving to convert the natural rubber molecule into aviation-grade gasoline while the American technician is wrestling with the problem of forcing the petroleum hydrocarbon to take its proper place in synthetic rubber.

At least the Japanese claim that in one of their broadcasts to the world. From this none-too-reliable source comes information that a factory has been set up near Kuala Lumpur, where dry distillation is the first step in converting the latex of the Hevea tree, after which the low-boiling hydrocarbons are subject to alkylation and hydrogenation for working into high-octane gasoline.

Adaptation of the natural rubber molecule, a consistent hydrocarbon, has been studied as a source of motor fuel in years past, especially in the Netherlands Indies.

Strange things happen in a world at war.

Economy By Edict

OVER in OPA there is edict which holds retail prices of oil at anchor. From the Office of the Petroleum Administrator for War comes edict to make more heating oil and less gasoline from a barrel of crude. If producers are successful in getting a higher price for crude oil, edict will precede it.

Just how refiners are going to pay more for raw materials, make less high-valued material and sell at the old price schedule makes for economic puzzle. Perhaps some other agency will be set up, whose function will be to assure profit by edict. More than mirrors are required in this accomplishment, consequently there may be delay in its perfection.

Washington has an agency of this sort, RFC, which through many little corporations takes care of the financially lame. Refiners are being courted with dollars. This is known as a bounty. Many within the petroleum industry are wary of the bounty. They know it is impossible to disobey the suggestions of the man who brings the bounty.

What seems strange is that the men who question edict economy are branded as unpatriotic. Evidently there is belief that patriotism can be assured by edict.

Return To 1942

WHEN the automobile plants come to a halt on military production and return to the making of automobiles, their first output will be models identical with 1942. This is the opinion of Alfred P. Sloan, chairman of the board of General Motors Corporation.

Reason for this will be that design and much of the machine tools for the 1942 models are available. Those new creations, wherein plastic will replace metal, rubber replace fabric and smaller motors, rear-axle mounted, will replace the heavier units, must be designed.

Engineers have only the vision of what can be done with the improved materials and manufacturing methods. While adapting this vision to plant practice, the old equipment will return to the plants and the public will get cars like the ones that came down the lines in 1942.

Big Job

MAGNITUDE of the program of providing plant capacity for 100-octane aviation gasoline, toluol, butadiene and other critical war products from oil was outlined by Bruce K. Brown, Assistant Deputy Administrator of PAW, before a subcommittee of the House of Representatives in November. He estimated that $80,000,000 had been invested in the special processing equipment for this gasoline prior to Pearl Harbor; that the daily output of this gasoline will be increased 10 fold through installation of additional equipment to cost $500,000,000.

His summary of this plant expansion was:

"Upon completion of the present program 19 major oil companies and 31 smaller independent companies will be playing a part. As I have previously indicated there is a very intimate relationship between the production of aviation gasoline and synthetic-rubber raw materials from petroleum and a considerable number of plants producing butadiene and butyl rubbers are being built by Defense Plant Corporation under the auspices of the office of the rubber director and Rubber Reserve Company as a more or less integral part of our petroleum refining war program. The plants producing toluol either by extracting it from petroleum or by a chemical process using naphtha as a raw material are also included in the petroleum refinery war program.

"In recent months the progress of construction of these plants has been impeded by a disturbance in the priorities system and an ever increasing shortage of certain essential pieces of equipment. A strenuous effort is now being made to bring these petroleum and synthetic-rubber projects which are so essential to the winning of the war into a satisfactory construction schedule by the definite allocation of the necessary materials."

Sulphur Compounds from Panuco Gasoline

WALTER FRIEDMANN and CESAR CANSECO
Petroleos Mexicanos, Laboratorio de Investigacion,
Gerencia de Refinerias, Atzcapotzalco, D. F.

SOME TIME ago an investigation was reported,[1] referring to the action of sulphur upon different hydrocarbons under pressure. We expected to find sulphur compounds which might be present in Mexican oils.

In the course of the research work, starting from iso-octane, we succeeded in synthesizing thiophanes, the sulphur compounds which the Pánuco oil we are dealing with here contains in notable quantities. This crude has another peculiarity in that its vanadium content is worthy of notice, but we do not know yet in which form the element occurs. However, the fact upon which we like to draw attention is that the same peculiarities are characteristic of Persian crude oils,[2] which also have high vanadium content and at the same time a remarkable amount of thiophanes. The simultaneous occurrence of these two components, in some way, could be correlated.

As regards the thiophanes, the cyclic sulphides $C_n H_{2n}S$, Mabery[3] discovered in the acid sludge from a Canadian petroleum, some English investigators[4] consider Mabery's use of the term "thiophanes" unfortunate, so much the more "when describing a class of substances of which Mabery had not identified a single member. The lowest member of the series separated from Canadian petroleum was C_6, $H_{12}S$, boiling at 45-50° C. at 50 mm. corresponding to 125-130° C. at ordinary pressure, which may be (a) hexamethylensulphide, bpt. at 170° C., or (b) a methylpenthamethylen sulphide bpt. at 151-152° C., or (c) a dimethyl tetramethylen sulphide bpt. at 142° C. Mabery's conclusions might well be correct, but they seem to be based on somewhat insufficient evidence."

In spite of this criticism, Mabery's working method was followed by us, that is the acid sludge from Pánuco gasoline served as starting material instead of trying to isolate the sulphur compounds from the crude oil itself. But this method cannot be rejected because in accordance with other investigators we proved[5] that the open chain sulphides, the same as the cyclic ones, the thiophanes, are perfectly soluble in concentrated sulphuric acid and that these compounds separate unchanged from their solution by adding water.

Besides, Emmet Reid[6] is correct when stating: "No one, even with modern precision stills, has been able to isolate the sulphur compounds by fractionation alone."

It may be instructive to begin with the study of the distribution of the sulphur compounds in the Pánuco crude, which contains as an average 4.9 percent of sulphur (Figure 1). The sulphur content in the consecutive main fractions distilling between 75° C. and 165° C. rises from 0.06 percent to approximately 0.7 percent and slightly above this range, the sulphur reaches 1 percent. This being the case, it seems reasonable to treat only raw gasoline with an end point below 150° C. when a high-grade gasoline is to be produced. For this very reason only the sulphur compounds present within the temperature range of 75-140° C. have been isolated and identified proceeding in the following way:

General Procedure

An acid sludge which had been formed in refining Pánuco gasoline with concentrated sulphuric acid (E P 175° C.) was drawn, settled, separated from the gasoline and diluted with ice and water.

The light tar which separated was neutralized with lye and steam distilled until no more oil came over. A considerable amount of resinous matter not yet investigated remained in the still, 60 liters steam distilled, golden yellow oil, D_{20}—0.917, were recovered; its terpene-like odor was not unpleasant in spite of the high sulphur content of 21.7 percent.

Fractional Distillation

4.5 liters of the sludge oil were roughly fractionated into 12 cuts:

J. B. Pt.....	72°			
	82°		10 cc.	
	83	116°	40 cc.	0.8366
	117	134°	100 cc.	0.8879
		135°	100 cc.	0.8950
		136°	100 cc.	0.8980
		137°	100 cc.	0.9004
	137.5	139.5°	400 cc.	0.9005
	140	142°	400 cc.	0.9110
	142.5	144°	700 cc.	0.9130
	145	147°	600 cc.	0.9140
	148	149°	300 cc.	0.9135
	149.5	151°	400 cc.	0.9117
	152	155°	500 cc.	0.9110
	Residue		665 cc.	0.9266

Each cut was redistilled several times taking 2° cuts and these cuts were then combined into groups depending on their gravity or sulphur content, they were submitted to further fractionation until fractions of a certain boiling constancy were obtained.

However, in no case were pure sulphur compounds obtained by fractionating overhead products. Later investigation will determine whether azeotropique mixtures are formed or not. Even the cuts, which according to the boiling points could be considered as almost pure were not a suitable material for the preparation of derivatives which had to identify the sulphur compounds.

On the other hand, the preparation of the mercuric chloride additive products and their recrystallization until the melting points remained constant have proved a practical way. Repeated recrystallizations were inevitable when the alkylated thiophanes appeared as isomers, which, as a rule, were roughly

separated in three or four recrystallizations of the additive products. The purified additive salts were decomposed by sulphide of sodium, the liberated thiophanes driven off with steam, the aqueous distillate extracted and the dry extract rectified.

Only the thiophanes are mentioned because no sulphur compound, so far separated from a main cut or from an intermediate one, could be identified as open-chain sulphide.

The boiling points given in this paper refer to a level of 2200 meters or 585 mm. Hg, consequently our data seem to differ considerably from those stated by other investigators. But after correcting the data for 760 mm. Hg, the discrepancies disappear and our data, compared to those given for the compounds synthesized by von Braun[7] and Grischkewitsch-Trochimovski,[8] are coincident within the normal tolerance.

The constants of the following table originate from the publications of the Russian investigators, the boiling points of some cyclic sulphides at 585 mm. Hg. corresponding to those at 760 mm. Hg. have been added.

	Bpt. C°	Bpt. C° 585 mm.	d 18/40	n_D^{18}
Tetrahydrothiophen	118—19°	110.5/11.5°	0.9607	1.4871
2—Methyl Tetrahydrothiophen	132.5° (750 mm)	124.5°	0.9564	1.4886
3—Methyl Tetrahydrothiophen	137.5—385° (740 mm)	130°	0.9596	1.4886
2-2 Dimethyl Tetrahydrothiophen	142° (756 mm)	134°	0.9175	1.4752
Pentamethylen-sulphide	141.5—142° (747 mm)	133.5°	0.9943	1.5046
Methyl Pentamethylen-sulphide	154.5° (151.5°)	145.7°	0.9616 (0.9449)	1.4884
Hexamethylen-sulphide	169—171° (747 mm)	160.8°	0.9743	1.5044

Derivatives Serving for the Identification of Thiophanes

As stated before, the very characteristic mercuric chloride complex salts have to undergo repeated recrystallizations from alcohol or a mixture of benzene acetone (1:1) before reaching the essential degree of purity. As a rule, the solubility of the mercury additive salts derived from the isomers or homologues of the thiophane series in those solvents differs sufficiently to secure one by one the separation of the components of mixtures. But when simultaneously mixtures of isomers or homologues with one, two or three mols of mercuric chlorides precipitate, mostly in the oily state, the separation includes heavy losses in substance and requires some patience.

Relative to the melting points of mercury salts, in general, the heating has to be performed under equal conditions. It is advisable to make first a tentative melting point determination and to repeat with a fresh sample, under equal heating conditions, placing the melting-point tube in the bath at 10° to 15° C.

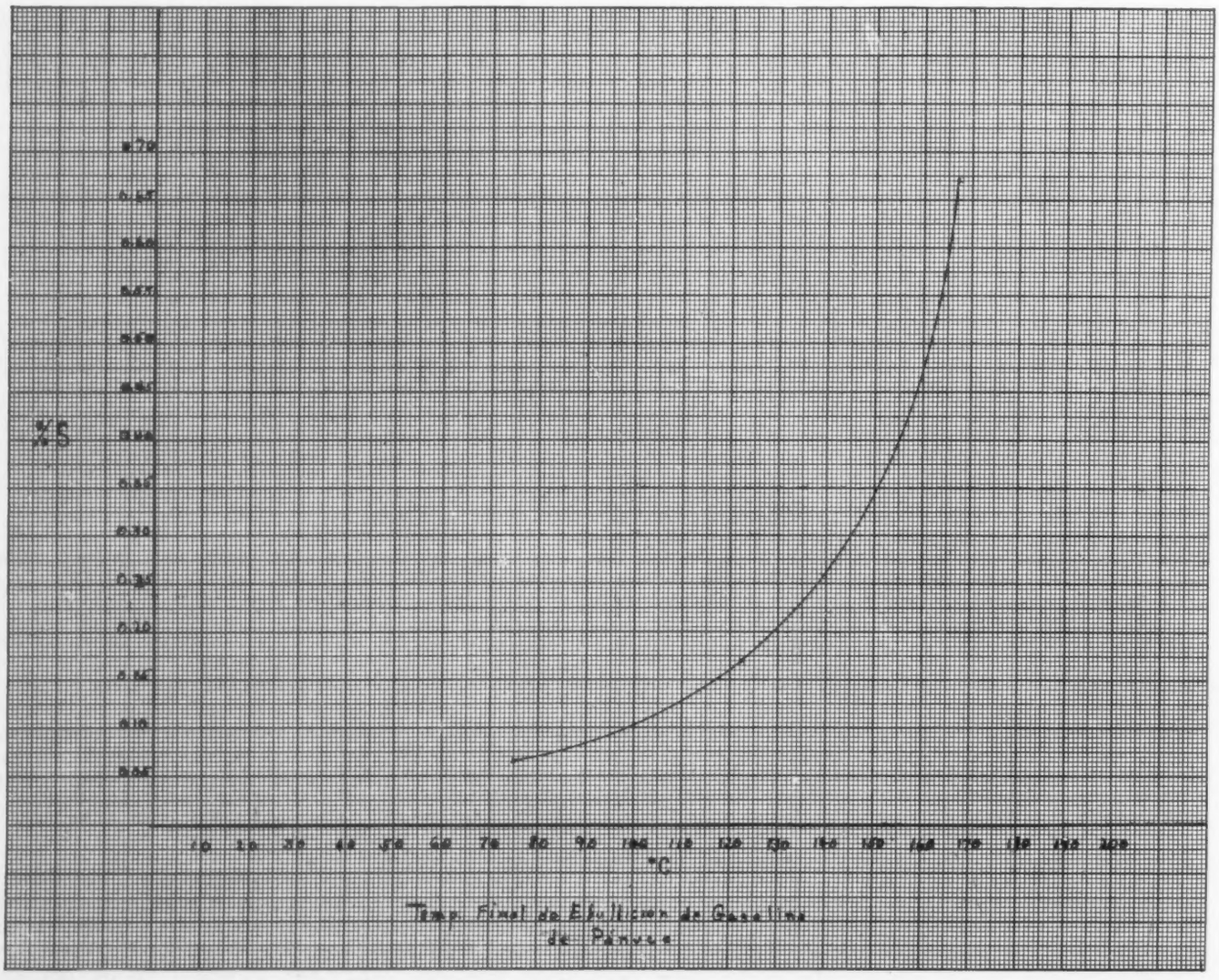


FIGURE 1

below the melting point temperature found in the previous determination.

Some melting points of mercury salts prepared in the course of this investigation from pure thiophanes differ substantially from results in a previous research work concerning the sulphur compounds of the Pánuco oil. The latter, however, have not been isolated as thiophanes in pure state, only mercury salts had been prepared, "the sulphides were not identified," (Science of Petroleum, Vol. II, p. 1039). As the original publication was not available, only the abstract[9] was available, we could not go into details concerning the differences.

The sulphonium compounds resulting from the interaction of thiophanes with methiodide show no melting points, but volatize without melting. Therefore, as referred to by other investigators,[10] the sulphonium compounds were transformed into the mercuric iodide additive products by means of an excess of mercuric iodide in alcoholic solution, the precipitates formed showing clear melting points:

$$C_n H_{2n} S, CH_3 J + Hg J_2 — C_n H_{2n} S, CH_3 J, Hg J_2$$

Sulphones RSO_2, free from sulphoxides RSO, are readily formed by oxidation of the thiophanes with "perhydrol" in excess. Some sulphones of the thiophane series are solids, some are liquids, the latter boiling around 280° C. Owing to the high boiling points the liquid derivatives do not seem very fit for the proper characterization of thiophanes.

The platinum chloride additive products are characteristic crystalline compounds, but the high price of the reactive prevents the preparation of larger quantities which are necessary for the separation of isomeric products.

The following reaction for the identification of cyclic sulphide is proposed:

When the octylthiophane $C_8H_{16}S$ and the thiophane polysulphide $((C_8H_{16})\ 2\ S_6)$ x were synthesized, starting from iso-octane[1] an interaction of those compounds with 2, 4-dinitrophenyl-hydrazine was first noticed, but not published. The same reaction was observed between the thiophanes isolated from the Pánuco gasoline and the reactive mentioned. So far the mechanism of the reaction has not been cleared up; this being the case, we reserve the detailed study of this reaction for later consideration, including an investigation of the behavior of open-chain sulphides.

The following fractions of the sludge oil from the Pánuco straight-run gasoline are being dealt with in this study:

(1) 82°-110° C.; (2) 112°-116° C.; (3) 122°-124° C., 124°-126° C.; (4) 129°-131° C., 132°-133° C.

Fraction 82-110° C.

The volume of the successive fractions distilling between 82° and 110° C. was too small to be handled with good results, moreover, the respective sulphur contents, the densities and the refractive indices indicated the presence of only small quantities of sulphur compounds.

Fraction 112-116° C.

By systematic fractional distillation a cut was obtained showing the following properties:

Bpt. 112°-116° C. d_{20} 0.847, $\frac{n}{D_{20}}$ 1.4425, S 10.2 percent

Avoiding an excess of mercurichloride, 550 cc. of an aqueous mercurichloride solution containing 70g in one liter were added to 25 cc. of the above fraction gradually and well shaken for about an hour.

A white precipitate immediately formed which became perfectly solid when all mercurichloride was added. The separated solid was dried on a porous plate yielding 35g of crude complex salt which was recrystallized from alcohol. When the solution cooled needles readily separated (16g) over night 4g more of the needles came down. The same operation was repeated twice, each time with 25 cc. of the fraction, yielding a total of 60g recrystallized complex salt.

The different mother solutions were united and concentrated, but when crystals separated they were kept apart from the needles.

In spite of three further recrystallizations of the needles, no clear and constant melting point was obtained, an inconvenience which we met likewise when other derivatives were prepared with the fraction 112-116° C. as starting material.

Therefore the purified mercuric salt had to be decomposed with the calculated amount of sodium sulphide and steam distilled. When no more oil came over the distillate was extracted with ether yielding 12 cc. of the dry sulphur compound, which distilled as follows:

Up to	114.5°	1.5 cc.		
Main fraction	114.5/115°	10 cc.	$d_{20/4}$°	0.9818
			$\frac{n}{D_{20}}$	1.5008
	115 /116°	0.5 cc.		

The odor of the product was not unpleasant, by rectifying same once more, the bpt. remained unchanged, but the density decreased to 0.9773, $\frac{n}{D_{20}}$ 1.4990.

From a sulphuric acid sludge from Persian petroleum, Thierry[11] isolated tetrahydrothiophen stating as bpt. 760 mm. 120-121° C.

The pure thiophane served for the preparation of derivatives, especially of:

1. The mercurichloride salt was obtained as indicated, avoiding an excess of mercurichloride. It precipitated immediately as a white product without being sticky. On one recrystallization from hot alcohol the delicate white needles, after drying, melted sharply at 125-126° C., in conformity with the statements of other investigators referring to the monomolecular mercurichloride salt from tetrahydrothiophen. The analysis gave:

$C_4 H_8 S, Hg, Cl_2$	56.22%	Hg, As HgS
	55.78%	Hg.

2. The methiodide derivative precipitated immediately by mixing the thiophane with some excess of methiodide. Very soluble in alcohol, a considerable loss occurred by recrystallizing and drying the compound on a porous plate. It volatized at 186-190° C. As pointed out before, the methiodide dissolved in alcohol was treated with an excess of mercuri iodide and warmed until the white solution turned into yellow.

3. When cooling down, yellow needles separated, the merucic iodide of the methiodide $C_4 H_8 S, CH_3 J, Hg J_2$, which after washing with n-heptane showed a clear mpt. 112-113° C.

4. The phenylhydrazine derivative was prepared by adding 1 cc. of the thiophane, dissolved in 3 cc. abs. alcohol, to a solution of 2, 4-dinitrophenylhydrazine in the minimum amount of concentrated sulphuric acid. After standing for 15 minutes the mixture was diluted with 10 cc. abs. alcohol and heated 15 minutes on

the water bath. After cooling the yellow solution became a cake of shiny yellow crystals. After recrystallization of the new compound from nitromethan or ethylacetate it gave a clear melting point.

In oxydizing the crude material, d = 0.847, with an excess of "perhydrol" the resulting oil, after removing the solvent, could not be solidified in a freezing mixture, the sulphone of the tetrahydrothiophen melting at 8°-10° C.

On the other hand, the same crude material treated with an alcoholic solution of platinum chloride gave the chloroplatinate, although not in pure, unobjectionable condition, melting point 175-178° C.

The Complex Salt $C_5 H_{10} S$, 2 Hg Cl_2

As mentioned before the mother solutions from the needles mpt. 125-126° C. were concentrated and the precipitated crystals were kept apart. Every crop was recrystallized by using a mixture of acetone-benzene (1:1) as solvent. On basis of the melting points determined for each crop the corresponding products were recollected and recrystallized from acetone-benzene (1:1). This rather painstaking method provided at last two compounds in pure condition:

(a) the needles C_4H_8S Hg, Cl_2 mpt. 125-126° C.
(b) plates $C_5H_{10}S$ Hg, Cl_2 mpt. 161° C.
The analysis of the latter gave 62.8 percent and 62.6 percent Hg
$C_5H_{10}S$ 2Hg Cl_2 requires 62.2 percent Hg
C_4H_8S 2Hg Cl_2 requires 63.6 percent Hg

We consider the second mercuric complex salt as a derivative of one of the $C_5H_{10}S$ compounds, the following experiment giving a support for our opinion. After decomposing the compound melting point, 160-161° C. with sodium sulphide, the resulting oil served again for the preparation of the mercuric complex salt, but using an insufficient quantity of mercurichloride. In spite of all possible care taken the precipitated salt, after recrystallization, was identical with the one with which we started the experiment, showing the form of plates and melting point, 160-161° C., but not the form of the needles melting point 125-126° C.

Fractions 122-124° C. and 124-126° C.

(a) 122-124° C.	d_{20}	0.9112	$\frac{n}{D_{20}}$	1.4715
(b) 124-126° C.	d_{20}	0.9168	$\frac{n}{D_{20}}$	1.4780

The two fractions differed only slightly in their general behavior, therefore the experiments of the two series are not given separately. Neither a nor b were the proper material for preparing derivatives, always mixtures of compounds were obtained.

Consequently we had to return to the conversion of the oil to the mercuric complex salts as intermediates, recrystallizing same three to four times. As the same procedure was followed as described for the fraction 112-116° C., we refrain to repeat the description of the different stages of the procedure. But one special reference is necessary; the precipitated mercuric salts contained much more oil than those of the previous fraction. This oil even reappeared in most recrystallizations of the precipitates unless the solution was decanted from the deposited oil. This procedure, naturally, involved considerable losses, but finally 73 g of the complex salt, three to four times recrystallized, free from oil were available for the decomposition with sodium sulphide. On treating this mixture with a current of stream a clear, colorless oil came over with the condensed water from which oil was extracted by ether. The dry extract amounted to 15 cc. which on redistillation came over

	up to 123.5°	3 cc.				
(1)	123.5-125°	9 cc.	d_{20}	0.9518	$\frac{n}{D_{20}}$	1.4926
(2)	125.5-128°	0.8 cc.				
	Residue	0.5 cc.				

Starting with (1) as primary material the complex salt was prepared avoiding an excess of mercurichloride. The resulting precipitate was free from oil after three recrystallizations from alcohol and without adding crystals from later crops, the melting point rose from 142° to 152° C. Further crystallization failed to change the melting point of the brilliant plates.

The salt was analyzed:	53.84 percent Hg
$C_5H_{10}S$, Hg Cl_2 requires	53.62 percent Hg

The melting point of the monomolecular mercuric complex salt deriving from the methyltetrahydrothiophen is stated by other investigators to be 152° C. Only in the research work referring to the Pánuco oil a melting point of 125-127° C. is reported.

On concentrating the united mother liquors mentioned before, a crystalline product precipitated consisting in its major part of the plates melting point 152°. At the same time groups of needles arranged in concentric form were observed. On further concentrating the mother solution and resulting crops contained more and more needles, which were separated by hand. After repeated recrystallizations the needles melted sharply at 82-83° C. Grischkewitsch and Trokimovski give 82-83° as melting point of the mercuric salt from 3-methyltetrahydrothiophen.

The complex salt prepared from (2) contained more oil than the one prepared from (1). After separating the oily part and heating the decanted alcoholic solution with charcoal under reflux and concentrating same, crystalline mixtures deposited. Much time was spent in attempts to obtain homogeneous products, finally the 2-methyltetrahydrothiophen salt, melting point 152° C., was obtained, same as the needles melting point 80.5-82° C. and a very small amount of a third product consisting in needles melting point 122-123° C.

The quantity of the compound resulting from the decomposed salt melting point 80.5-82° C. was not sufficient to ascertain the boiling point of the corresponding sulphur compound, 3-methyltetrahydrothiophen is reported to boil at 137.5-38.5° C., 760 mm.

The definite examination was deferred till larger quantities could be obtained.

It was hoped to establish the identity of the compound $C_5 H_{10} S$, 2 Hg Cl_2, isolated from fraction 112-116° C. as derivative of 2 or 3-methylthiophane. For this purpose the pure methylthiophane (1) was poured very slowly into a saturated aqueous solution of mercuric chloride, maintaining in this way an excess of mercury. The precipitate obtained after 27 hours standing seemed to be a complex mixture, no definite product was isolated.

From the 2-methylthiophane (1) the methiodide was prepared, very soluble crystals volatizing at about 175° C.

On oxydizing the methylthiophane with an excess of "perhydrol," a strong reaction took place at the beginning. On concentrating the mixture the odor of a fatty-acid like butyric acid was noticed, the sul-

phone remained as a heavy yellowish oil which distilled within 264-268° C., d_{20} 1.2077, $\overset{n}{D_{20}}$ 1.4755. In liquid air the oil became a rather opaque liquid.

The chloroplatinate was little soluble, the yellow crystals melting around 190° C.

The 2.4-dinitrophenylhydrazine derivative was prepared in the same way as described before. The ethyl acetate solution deposited yellow crystals.

The main component of fractions 122-124° C. and 124-126° C. is 2-methylthiophane the identity of which was established by its boiling point 123.5-125° C. and by the monomolecular mercuric complex salts forming plates melting point 152° C. These properties agree with those stated by Grischkewitsch-Trochimovski for the synthetic 2-methylthiophane. The 3-isomer has not yet been identified, but the melting point of the mercuric salt in form of needles at 82° C. is in conformity with the melting point of Grischkewitsch's synthetic monomolecular complex salt from 3-methylthiophane. Regarding the very small amount of needles melting point 122-123° C. no definite conclusion can be drawn as for the corresponding sulphur compound, possibly, it is not a chemical individual but a mixture.

Fractions: (a) 129°-131° C. (b) 132°-133° C.

(a)	d_{20}	0.9267	$\overset{n}{D_{20}}$	1.4795
(b)	d_{20}	0.9290	$\overset{n}{D_{20}}$	1.4815

(a). The volume of (a) was only one third of (b). It was rather difficult to elaborate (a) because the precipitated mercuric salt turned out oily, besides, about one half of the material was lost in a fire accident. Nevertheless, as a main product a mercuric complex was obtained in silvery plates, very little soluble in alcohol, along with a small quantity of needles readily soluble in alcohol. The oily part was treated with different solvents and finally obtained more of the two compounds mentioned.

In spite of repeated recrystallizations the main product remained sticky, the melting point was not sharp, around 130° to 133° C. As the same products were obtained in unobjectionable condition from (b) it seems sufficient to describe only the elaboration of fraction 132-133° C.

(b). The mercuric salt was prepared as usual from 50 cc. of the oil 0.9290, adding under agitation slowly 1530 cc. aqueous solution of 107g mercurichloride. At once the complex salt precipitated, it was separated and drained on a porous plate, became perfectly dry and free from oily material. However, on dissolving the salt in alcohol, a small amount of oil was noticed, from which the solution, still warm, was decanted. On cooling, the less soluble crystals soon precipitated. They were recrystallized twice from alcohol, showing then the form of silvery plates.

Next 40g of this salt were treated with steam, first in neutral, later in sodium sulphide suspension (94g in 200 cc. water). The neutral distillation gave a few drops of an oil with a very strong terpene odor. In view of the very small amount obtained the definite examination of the substance had to be deferred until more of the product could be collected.

The main bulk of the oil resulting from the decomposition with sodium sulphide was extracted with ether from the destillate, recovered and distilled.

11 cc. of the dry extract gave:

up to 130°	1.5 cc.	
130.5-132°	8. cc.	d_{20} 0.9752, $\overset{n}{D_{20}}$ 1.5028 S — 31.07%
Residue	0.8 cc.	

The sulphur content and the physical properties correspond to the pentamethylen-sulphide $C_5 H_{10} S$, as the boiling point agrees with the one stated by Thierry for the pentamethylen-sulphide isolated from the Persian oil.[12]

This pure product served for the preparation of the mercuric complex salt. After two recrystallizations, the plates melted sharply at 137-138° C. Its analysis indicates the monomolecular mercuric complex salt $C_5 H_{10} S$, Hg Cl requiring 53.65 percent Hg. This product is stated by Bost and Conn[12] to melt at 137.5-385°, the same data are given by Grischkewitsch-Trochimovski[13] for the complex salt of the synthesized pentamethylen-sulphide.

As a further check on the identification of this compound it was converted to the methiodide. In conformity with the statement of Bost and Conn the methiodide $C_5 H_{10} S$, $CH_3 J$ volatized at 190-195° C.

The 2, 4-dinitrophenyl-hydrazine derivative, obtained by the method mentioned before, as shown by its color and its crystalline form, is very much like those obtained from tetrahydrothiophen or the methyl homologues.

The mother-liquors resulting from the different crystallizations of the mercuric complex melting point 137-138° C. were united and concentrated yielding at the beginning more of the silvery plate melting point 137-138° C. On further concentration the successive precipitates were found to be mixtures which had to be separated by fractional crystallization, a rather tedious procedure. Finally a homogeneous product was obtained in form of long needles, very soluble in alcohol, melting point 168° C.; further crystallization failed to change the melting point, but, so far, the amount of the complex was too small for the identification of the corresponding sulphur compound.

The investigation being still on its way, conclusions are postponed for the second part of the publication. Nevertheless, at present one aspect shall be pointed out: the sulphur compounds we are dealing with bear high technical interest.[15]

In general, one prominent technical task consists in converting waste products in consumable goods. The production, this way, is amplified and diversified with the aid of existing means, whereby, simultaneously the inherent value of the primary material is increased.

The oil industry can not afford to throw away any longer products which, so far, are little known due to their absence in the markets by the fault of the refiner. But when the thiophanes are segregated, thus put at the disposal of the organic chemical industry, they promise to serve as solvents or as raw material for new products, giving rise to new possibilities for technical progress.

REFERENCES

[1] Walter Friedmann, Refiner, October, 1941.
[2] Science of Petroleum, Vol. I.
[3] Am. Chem. Jl. 1906, 35, 422.
[4] Challenger, Jl. Inst. Petr. Techn. 1926, Vol. 12, p. 108, discussion p. 138.
[5] Walter Friedmann, Refiner, October, 1941.
[6] Science of Petroleum, Vol. II, 1936.
[7] Chem. Ber. 1910, 43, 549, 3220.
[8] Chem. Soc. Abstr. 1917, 153/59.
[9] J. Teutsch, Chem. Abst. 28, 1934, 4872.
[10] Challenger, Jl. Inst. Petr. Techn. 12, 1926, p. 125/6. Thierry, J. Chem. Soc. 1925, 127, 898, 1934.
[11] J. Chem. Soc. 1925, 2756.
[12] J. Chem. Soc. 1927, 127, 2756.
[13] Ind. Eng. Chem. 1931, 23, 93.
[14] Loc. Cit. p. 8.
[15] Mex. Pat. 41.194,29 Sept. 1941, assigned to Petroleos Mexicanos.

What Takes Place in Thermal Cracking

PAUL H. FAUST
Chemist, General Petroleum Corporation

THE most economical utilization of crude oil has long been the goal of petroleum technology. In earlier years, it was simply fractionated so that maximum cuts could be separated within the specifications of the most valuable products. Basically different is cracking, which actually alters the boiling ranges of petroleum fractions. This process was first applied on a commercial scale when the Burton still was developed in 1910.

Cracking is chiefly used to produce gasoline from heavier, less valuable petroleum stocks; therefore, this change will receive first consideration. Other important aspects of cracking, including the coke problem and the nature of cracked products, will follow. The significant development of catalytic cracking will be discussed separately in a future article.

To refinery workers crude oil is composed of gasoline, kerosine, wax, etc.; but chemists choose to picture it as a mixture of enormous numbers of individual chemical compounds. It is perhaps unfortunate that without taking the chemists' viewpoint one can hardly expect to grasp thoroughly the varied aspects of cracking. By way of introduction, these compounds in petroleum are almost completely made up of carbon and hydrogen atoms, which are joined in several different ways to form the hydrocarbon class of compounds. The influence of the particular manner in which the atoms are combined will be shown, but now it is sufficient to illustrate, as is done in Table 1, merely the effect of number of carbon atoms in these hydrocarbons.

Gasoline is thus shown to contain hydrocarbons with from 5 to 12 carbon atoms, while the heavier fractions contain more and the gases fewer.

On Molecule Breaking

Obviously, if the molecules in these heavier fractions are broken into fragments containing from 5 to 12 carbons, a valuable conversion is effected. As a matter of fact, we know that above 700° F. some of these larger hydrocarbons do become unstable and break into smaller parts. Thus a molecule consisting of a straight chain of 16 carbon atoms and boiling at 545° F. might break into 2 molecules, each containing 8 carbons and boiling around 259° F. Then each of these molecules is liable to subsequent rupture, so that gases are formed if the reaction is carried out long enough. However, the smaller molecules require a higher temperature for decomposition, so that if conditions are maintained correctly, the hydrocarbons in the gasoline range are relatively stable as compared with those of the charge stock.

What, then, is to prevent the complete conversion of heavier stocks to gasoline? Two things primarily; first the heavier hydrocarbons do not always split right in the middle. In the foregoing example, the 16 carbon atoms as well have formed fractions of 2 and 14 carbon molecules. In other words, the formation of gas in cracking is inevitable.

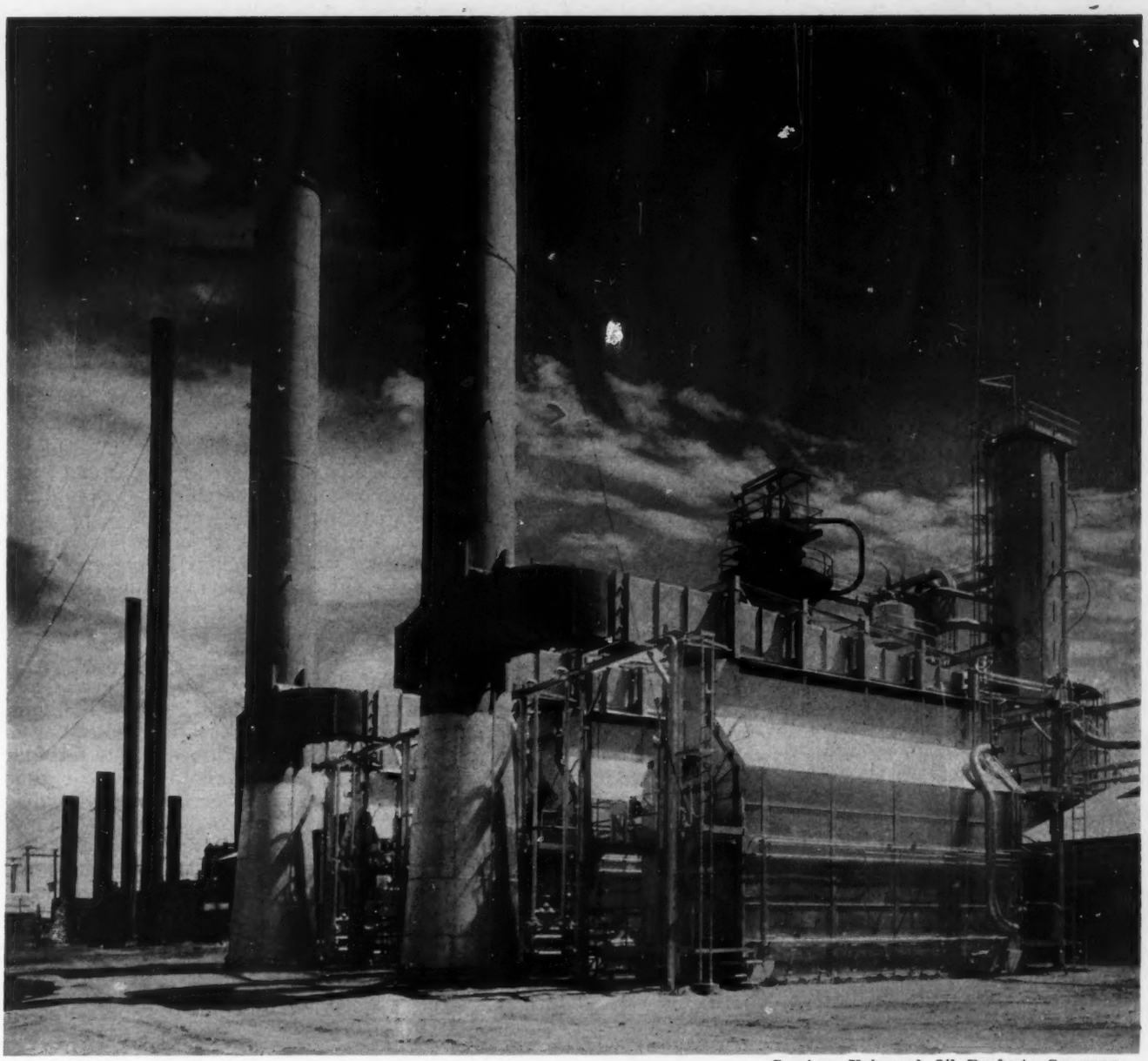
On Molecule Building

The second hindrance to this ideal cracking yield is the presence of a varying amount of substances in all crudes which, instead of breaking down tend to build up forming progressively larger molecules that finally are deposited as coke on the cracking tubes and along the route of the cracked stock. These coke-forming substances are basically different because they contain differently formed molecules—stable molecules with carbon atoms joined in the shape of rings and not in straight or branched chains with vulnerable open ends. Attempts to select crudes without these ring-containing molecules (the so-called "aromatic" and "asphaltic" compounds), or to pretreat cracking stocks to eliminate them, are to no avail, however, because such compounds are formed from the other constituents of crude oil under cracking conditions.

Since eliminating the cause of the trouble is impossible, cracking units are designed either to prevent coking as much as is practical, or to control the process in order to recover a marketable product of petroleum coke. Advantage is taken of the fact that a certain period must elapse before these cyclic molecules are built up large enough to be deposited out of the hydrocarbon stream. The time of passage through the furnace is so adjusted that a minimum of

TABLE 1

Number of carbon atoms	Approximate average boiling point (°F.) of those hydrocarbons containing the stated number of carbon atoms
1	—259
2	—130
3	— 50
4	+ 30
5	100
6	160
7	215
8	260
10	345
12	420
14	490
16	550
18	600
20	640



—Courtesy Universal Oil Products Company

Thermal Cracking Unit

coke deposition occurs there. Then, immediately upon leaving the furnace, the hot oil either may be "quenched" with some cooler stream to stop the "building up" reaction, or may be allowed to continue cracking in a vessel from which the coke is easily removed.

Inasmuch as cracking of any stock produces a complete boiling range of hydrocarbons from gas to coke, it would seem economical to recycle the undesired fractions. Care must be taken, however, that no partly formed coke molecules are included in the recycle stock, for they would certainly deposit out soon after entering the furnace. Since such molecules impart a dark color to the stock, their elimination is attained simply by fractionating to a light-enough color, as determined by experience. That cracked residuum must never be recycled is a well-known rule.

Some Variations

By modifying the cracking conditions and the amotunt of recycle stock, cracking processes may be carried out either to produce only gasoline, gas, and coke (in which case interchangeable coking vessels are used immediately following the furnace), or, in the opposite extreme, primarily to reduce the viscosity and pour point of the charging stock, with only an incidental production of gasoline. In the former case high temperatures are used, while in the latter, in "vis-breaking units," comparatively mild conditions prevail to prevent excessive coke and gas formation. The principle of viscosity breaking is that the "open-chain" molecules which break up on cracking are particularly responsible for high viscosities and pour-points.

In other cases, gasoline production is not sought at all, for as a result of certain chemical differences between cracked and straight-run stocks, new uses for this process have been found. Gases from natural and straight-run gasoline stabilizers may be charged into cracking units either to produce polymerization stocks, or at very high temperatures even to synthesize products such as benzene and toluene. In one instance, gasoline itself is cracked in "reforming units" chiefly because enhanced octane rating of the

fuel more than makes up for the loss in volume due to gas and coke formation.

On Olefin Forming

Apparently then, the boiling range is not alone affected in cracking. To explain why the chemical nature of cracked stocks is so different further note is taken of the important splitting reaction. The cracking of a heptane molecule illustrates, in Figure 1, the formation of what is called a "double bond"—the active "C=C" configuration in the butylene molecule. Hydrocarbons containing one double bond per molecule form a particular class of compounds called olefins.

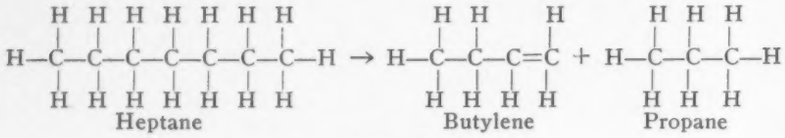


FIGURE 1

It will be noted that in heptane each carbon atom is surrounded by four other atoms, either carbon or hydrogen. This combining capacity of four must always be satisfied in carbon compounds; hence the necessity of the double combination of two carbons when, as a result of the division, there are not enough hydrogen atoms to go around.

These olefins may also be formed by "dehydrogenation," in which two hydrogen atoms are removed directly from the hydrocarbon, as in Figure 2.

The presence of small amounts of hydrogen in cracked gases indicates that dehydrogenation actually occurs in cracking to some extent.

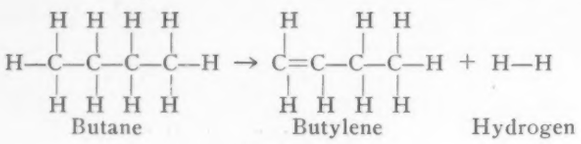


FIGURE 2

Resulting from one or the other of these processes is a small but important number of molecules, each with two double bonds—the diolefins. Attributed chiefly to these highly reactive substances is the formation of undesirable heavy polymers and oxidation products which cause color instability, gum formation, and decreased octane rating, in cracked gasoline. At least one diolefin has been spot-lighted in recent news, for the same tendency to polymerize has made butadiene important in the synthetic-rubber program. The lower pressure of vapor-phase cracking favors the production of such diolefins, while high-pressure cracking usually yields only traces of these compounds.

The mono-olefins themselves tend to polymerize (or recombine) to a considerable extent at cracking temperatures, so that the gases containing less than five carbon atoms, little of which can be incorporated into gasoline without raising the vapor pressure prohibitively, are often recycled in the cracking unit to produce some polymer within the gasoline range.

This tendency of mono-olefins to polymerize is fortunately not marked at ordinary temperatures. Although cracked gasoline may contain even 50 percent of olefins in some fractions, the product is permissible for use as a motor gasoline after the more reactive diolefins have been removed (by acid or clay treatment) or inhibited (by traces of several special compounds now on the market). The olefins, in fact, are a highly valued constituent of gasoline, for they so alter its ignition characteristics that engines can utilize higher compression ratios, with a consequent increase in efficiency— a long way of saying "high octane."

On Forming Aromatics

Contributing to the high-anti-knock value of cracked gasolines is their increased content of aromatic hydrocarbons (those containing the "benzene ring"). These compounds are formed from olefins and diolefins in complicated polymerization and dehydrogenation reactions in the cracking zone. The aromatics were mentioned earlier in the undesirable connection of coke formation, but before the rings start forming the big coke molecules, they are valuable constituents of gasoline.

Design of Molecules

In case some confusion has resulted from the concepts of straight and branched chains, double bonds, and "ring" compounds, representative molecules of these types are illustrated in Figure 3. Of the four hydrocarbons shown, each contains eight carbon atoms, yet their octane numbers are very widely separated.

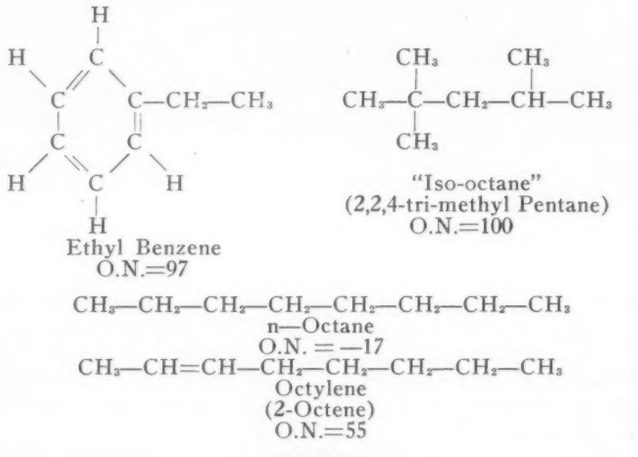


FIGURE 3

Ethyl benzene, consisting of an "ethyl group" attached to a "benzene ring," exemplifies the aromatic series in which this benzene ring is the distinguishing feature.

Normal (meaning straight-chain) octane and iso- (meaning branched-chain) octane are typical examples of the "open-chain" or paraffin series.

Octylene, a typical olefin, is the same as normal octane except for a double bond.

Although any of these molecules as well as myriads of other modifications of these basic variations, are formed in the cracking process, only the olefins do not occur in detectable amounts in the crude itself.

Emergency Use of Oil-Coal Suspensions as Colloidal Fuel

W. L. FAITH
University of Iowa
H. W. ZABEL
Kansas State College

A CRITICAL fuel-oil shortage occasioned by transportation difficulties has made a decrease in oil consumption imperative. In most cases this has meant the scrapping of oil-burning equipment as furnaces have been converted to coal burners. The disadvantages of such procedure are many and obvious. These are chiefly problems of handling, storage, burning efficiency, and flexibility, in which characteristics liquid fuels are notably superior to solid fuels.

With these thoughts in mind, it may be advisable for fuel users and government officials to consider the use of colloidal fuel (suspensions of coal in oil). It is possible to prepare such suspensions containing as high as 50 percent coal by weight and still retain many of the advantageous characteristics of fuel oil. In addition there are also the certain advantages of economy of use of present storage and handling facilities, and even more important, transportation economy. On top of this, we may have the added advantages of colloidal fuel over all other fuels. The two most noteworthy advantages in the present emergency would be the higher calorific value per unit volume, and the efficient use of local low-grade solid fuels.

Unfortunately, all of the technical problems involved in the economic use of colloidal fuel have not been solved. These problems have been pointed out by Hedrick[2]. In a time of emergency, however, it is often necessary to draw upon even the partial developments of normal times, and do the best that one can with the limited information at hand. It is the purpose of this article to point out how present knowledge may be adapted to the emergency use of oil-coal suspensions.

Manufacturing Problems

The essential steps in manufacturing colloidal fuel are (1) grinding and sizing the coal, and (2) mixing it intimately with the oil. It is possible that the two steps could be combined by grinding the coal in an oil medium, but since data on such a process are lacking, the two-step process is recommended for present use. The exact degree of comminution is an economic problem which remains unsolved. Hedrick[3] suggests 90 percent through 200 mesh as an optimum coal fineness, but states that 75 percent through 200 mesh would be satisfactory. Manning and Taylor[4] agree with this latter statement. In either case this degree of fineness could easily be obtained in ball mills, hammer mills, or ring-roll mills, of the types used in pulverized coal practice. Data in the Chemical Engineer's Handbook, pp. 2337-40[5] indicate the possibility of reaching a grinding cost of 50 cents per ton in large installations.

The technical and economic problems of mixing coal and oil are being studied by the authors, but only preliminary results have been obtained so far. These results indicate that a high-speed propeller mixer is satisfactory for preparing fuels in which the final viscosity is not over 80 seconds Saybolt Furol.

This figure is only approximate, but mixing experiments to date indicate that above this value thorough mixing does not take place. It is obvious that as the viscosity of the mix increases, more power is necessary, and that as the coal concentration is increased, a point is reached where the suspension loses most of its liquid characteristics. The final viscosity during mixing can of course be lowered by raising the temperature of the oil, and this procedure is recommended. Fortunately an equation has been developed[1] by means of which the viscosity of the suspension can be calculated directly from the viscosity of the oil itself at the same temperature, and the volume concentration of coal in the suspension. This equation is (for 200-mesh coal):

$$\frac{\mu f}{S_f} = \frac{38.4}{38.4 - C_v} \cdot \frac{\mu_o}{S_o}$$

where $\frac{\mu f}{S_f}$ = kinematic viscosity of the suspension

$\frac{\mu_o}{S_o}$ = kinematic viscosity of the oil

C_v = volume percent coal in mix.

For 325-mesh coal, the constant 38.4 should be replaced by 37.5.

Kinematic viscosities can be converted to Saybolt Furol seconds and vice-versa by means of the usual viscosity conversion charts.

It is recommended that in no case should one attempt to prepare fuels containing more than 50 percent coal by weight. Forty percent by weight appears to be a more satisfactory upper limit.

Handling the Fuel

An even greater problem than that of manufacture of the fuel is satisfactory subsequent handling. A fuel suitable for commercial use must be stable, that is, no appreciable settling of the coal shall take place in tanks and pipe lines; it must be capable of being pumped through pipe lines; and it must be easily atomized and mixed with air for combustion.

Of these problems, stability presents the greatest

difficulties. A great many stabilizers have been developed and patented by various investigators. Practically all of these (most of them are soaps and greases) are unsatisfactory because they increase the viscosity of the resulting fuel markedly. Several types of surface-active agents have been developed which are satisfactory from the standpoint of viscosity, but their cost and the difficulty of obtaining them because of priorities make their use uneconomical and impractical at present. Various cheap and widely available stabilizers are now being studied in the laboratories of Kansas State College. Some of these show considerable promise, but the work has not progressed far enough to allow a definite statement to be made. It is possible, however, to prepare a stable fuel without a stabilizer by proper preparation and handling of the fuel.

The tendency of coal to settle from an oil medium is dependent on the size of the coal particles, the viscosity of the oil, and the density of both materials. Hedrick, Andrews, and Sutherland[3] have also shown that electrostatic changes on the coal particles are an important factor in stability.

Under present conditions, however, there appears to be no reason why colloidal fuel could not be made by using coal of 98 percent through 200-mesh, limiting the oil to the more viscous fuel oils (greater than 45 Saybolt Furol seconds at room temperature), keeping the fuel moving in pipes and stirring it occasionally in storage. Experience in this laboratory indicates that the fuels listed in Table I may be used in this manner. The table also indicates the degree of stability of these fuels as determined experimentally.

Even under moderate vibrating conditions it should be possible to keep these fuels in suspension by periodic pumping from the bottom of a storage tank into the top, or in the case of smaller tanks by occasional stirring with a propeller or turbine stirrer. Such a method, of course, requires considerable power, but in many cases, it should be possible to use the same motors for both agitation and pumping.

The power required for pumping oil-coal suspensions through pipes has been determined by Gradishar, Faith, and Hedrick[1]. They have found that suspensions containing less than 38 percent coal by volume follow the usual laws of viscous and turbulent flow. In calculating the friction head in pumping colloidal fuel through pipes, the following equations may be used:

For viscous flow (low flow rates and coal concentration below 38 percent by volume):

$$\frac{H}{L} = \frac{V\mu_o}{D^2\rho_o} \cdot \frac{K_o}{K_o - C_v}$$

where:

- D = diameter of pipe in feet.
- H = difference in static head between two points in a pipe, feet of flowing substance.
- L = length of pipe, feet.
- V = mean velocity of flow in pipe, feet per second.
- μ_o = coefficient of viscosity of oil, pounds per foot second.
- ρ_o = density of oil, pounds per cubic foot.
- C_v = percentage coal by volume in suspension.
- K_o = 38.4 for 200-mesh coal.

(See reference No. 1 for further data.)

For turbulent flow the usual plots of Fanning friction factors vs. Reynolds number may be used, assuming the viscosity and gravity of the oil-coal suspension are the same as those of the oil medium itself. This assumption introduces only a very slight error.

TABLE 1

Stability of Oil-Coal Suspensions Containing 40 Per Cent by Weight Kansas Coal

OIL (Viscosity—Saybolt-Furol Seconds at 122° F.)	Coal (Mesh Size)	Temp. (°F.)	Time (Months)	Stability
303	200	180	1½	No appreciable settling
303	100-200	70	3½	Very slight sedimentation
46	200	70	3½	Little, if any settling
46	200	180	1½	Little, if any settling
178	200	180	1½	Little, if any settling

NOTE: The above data were obtained in static tests. Similar test under constant vibration resulted in more rapid sedimentation.

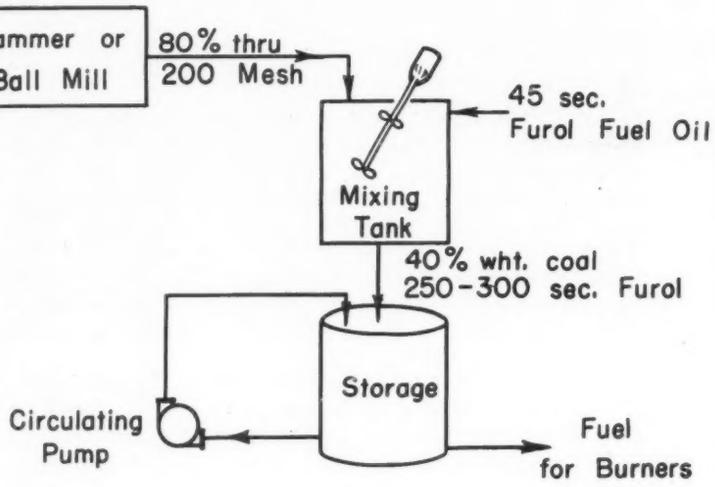


FIGURE 1

Flow sheet for typical colloidal fuel preparation unit.

For plastic or "plug" flow (coal concentrations above 38 percent by volume)

$$\frac{H}{L} = 32\left[\frac{\tau y}{\delta\rho D} + \frac{\eta v}{g\rho D^2}\right]$$

where

- τy = yield value of plastic fuel, pounds per square foot.
- η = coefficient of rigidity of fuel, pounds per foot second.
- g = acceleration due to gravity = 32.2 ft/sec².

In practically all cases of industrial importance, only viscous flow will be encountered, and calculations should be based on that assumption.

Atomizing and Burning the Fuel

Cursory experiments in this laboratory have indicated that colloidal fuel may be atomized previous to burning in the same manner as fuel oil is atomized. This is obvious when one considers that the flow characteristics of the fuel are essentially the same as the oil itself, if the coal concentration is kept below 40 percent by weight.

Some slight changes may be necessary in the design and operation of combustion equipment, but it is believed that emergency solutions to these problems can be devised by a competent test engineer.

In a specific instance, the burning of colloidal fuel in steam-locomotive boilers, Sanders[6] states: "The disposal of coal ash and slag residue would be somewhat of a problem, particularly if the slag should be carried over into the flues and adhere to the flow

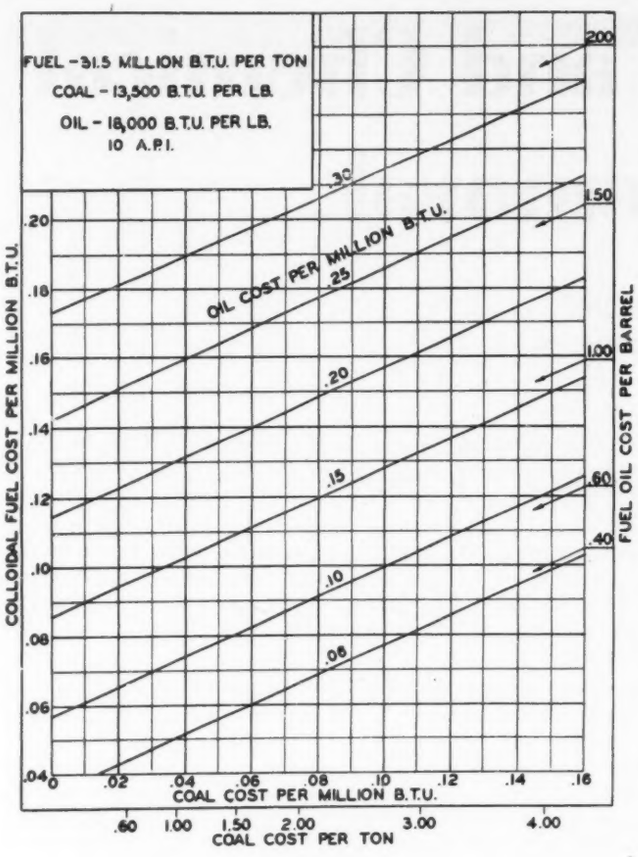


FIGURE 2

Colloidal fuel cost chart, 48.2 percent coal by weight.

sheet and flues, resulting in a restriction of the draft." Such problems, however, should not be difficult to overcome, particularly in view of the fact that many boiler plants are already successfully burning slag-bearing fuel oils and high-ash coals.

Typical Colloidal Fuel Preparation Plant

A typical flow sheet for a colloidal fuel preparation plant is shown in Figure 1. In this plant, the direct product of a hammer or ball mill may be used if 80 percent passes a 200-mesh screen. If the product is larger than this, a size-separator or air-classifier may have to be used. Satisfactory mixing may be obtained by adding the coal to the oil while stirring with a propeller-type mixer. In most cases, steam coils must furnish sufficient heat to lower the final viscosity of the mix. An off-center position of the mixer has proved to be the most satisfactory position in the limited tests that have been made by the authors. As mentioned previously, storage should be as vibration-free as possible. The use of a circulating pump may be necessary only for a short time each day, and could be arranged in such a manner that circulation and forcing fuel to the burners could be accomplished by the same pump. The flow sheet, however, shows only gravity flow to the burners. Further flexibility in operation may be obtained by the use of steam coils in the mixing and storage tanks.

Economic Factors

The economy of colloidal fuel use, based on available and assumed cost data, is shown graphically for a fuel containing 42.8 weight-percent coal in Figure 2. The graph is constructed on the assumption that the volumes of coal and oil are additive. Actually, because of volume contraction, colloidal fuel costs are from one to 4 percent less than are shown by the graph. The cost values per ton of coal and per barrel of oil may be used only for fuels of the calorific value shown in the upper left-hand corner of the chart. However, since the actual plotted values are in cents per million Btu, one can relocate the ton and barrel costs for fuels of other calorific values and use the same graphs to determine the cost of a resulting colloidal fuel.

In like manner, the chart must be changed for each different weight percentage of coal in the final fuel. This may be accomplished readily by changing the slope of the oil-cost lines. The slope of the lines in the chart are 0.428. For 30 percent-coal mixtures the slope must be changed to 0.30; for 50 percent mixture to 0.50, and so on. One point on the line must first be calculated and located, and the line of proper slope drawn through this line.

Graphs prepared in this manner take into consideration only raw material costs. To this must be added the cost of grinding and mixing. For estimating purposes, 50 cents per ton may be used for grinding, but unfortunately, no estimate can be made for mixing. Under the circumstances the best one can do is to calculate the fuel cost excluding mixing, then determine how much can be afforded for this operation. Comparison of this figure with some known mixing cost, such as grease formulation, might indicate whether or not consideration of colloidal fuel use is feasible.

Conclusions

Investigators of colloidal fuel manufacture and use have never concluded that it was a cure-all for all fuel problems. A stable colloidal fuel would be advantageous under a wide variety of industrial conditions, but unfortunately the stability problem has not been solved under all conditions of coal concentration and fineness, and oil viscosity. It is known definitely though that certain high concentrations of coal may be handled in the more viscous oils, and that the fuel will burn satisfactorily. Under present conditions, this fact should be weighed carefully before complete conversion from oil to coal is decided upon.

Acknowledgments

The authors wish to thank J. E. Hedrick for permission to use some data compiled by him; Standard Oil Company (Indiana) and Skelly Oil Company for fuel oil donations; and Pittsburg and Midway Coal Corporation for coal supplied to us.

LITERATURE CITED

[1] Gradishar, F. J., Faith, W. L., and Hedrick, J. E., Paper presented before Amer. Inst. Chem. Engrs., Cincinnati, Ohio, Nov. 17, 1942 (to be published in Transactions Amer. Inst. Chem. Engrs.).

[2] Hedrick, J. E., Mech. Engrg., **63**, 591 (1941).

[3] Hedrick, J. E., Andrews, A. C., and Sutherland, J. B., Ind. Eng. Chem. **33**, 1055 (1941).

[4] Manning, A. B., and Taylor, R. A., Trans. Inst. Chem. Engrs. (London), **14**, 45 (1936).

[5] Perry, John H., "Chemical Engineers Handbook," McGraw-Hill, New York, second edition, (1941).

[6] Sanders, E. G., Mech. Engrg., **63**, 920 (1941).

X-Ray Analysis and Chemical Scale Removal

S. C. MORIAN
Dowell Incorporated

REMOVAL of scale from various types of refinery equipment including economizers, condensers, heat exchangers and cooling coils has been a source of much trouble to the operators of this equipment. The mechanical removal of these scale deposits by hydrojetting and turbining has been generally unsatisfactory due to incomplete removal, long shutdown periods and delays in production schedules.

More recently interest has developed in the application of chemicals to industrial scale removal. This idea has been tried successfully on numerous occasions by industrial engineers. The success of chemical scale removal has been due to the acquisition of complete knowledge on the composition of the scale, proper selection of solvents, and the use of suitable addition agents to provide complete and speedy chemical reactions, and appropriate inhibitors to prevent acid corrosion of the equipment.

During the last year one large chemical service company has carried on some interesting and successful scale-removal operations involving over 100 different kinds of industrial equipment, including the usual types found in refinery operation.

In refineries the design flow rate of fluids through the equipment may exceed 4,000 gallons per minute at a pressure drop of 20 pounds across the unit. This high flow rate and pressure drop frequently result in deposition of a hard scale that reduces the efficiency of the equipment by retarding the rate of flow and the building up of the pressure necessary to continue normal flow rates. Operating temperatures are usually higher also. These scale deposits may form within a few weeks' operating period.

Recently, properly selected chemical solvents were applied to remove scale from an ammonia absorption refrigeration plant used by a large Gulf Coast refinery. The equipment that was descaled consisted of two condenser units and three absorber units. Each condenser unit contained 324 2-inch x 16-foot 11-gauge tubes, a total of 1,360 square feet of surface; each absorber unit contained 691 ⅞-inch x 16-foot 14-gauge tubes, a total of 4,358½ square feet. The grand total square feet of surface to be cleaned was 15,774.

All the tubes were manufactured from low-carbon steel. The capacity of the five units was 2,700 gallons. The designed total flow rate of the five units was 4,000 gallons per minute with a pressure drop of 20 pounds across them. The hook-up of these vessels as illustrated in Figure 1 shows that the three vessels of the single flow absorber were in series while the two vessels of the five-pass condensers were in parallel.

An analysis of the scale found in one of these units is given in Table 1.

The materials used in the removal of scale from this equipment consisted of 2,750 gallons of specially prepared solvents capable of disintegrating and dispersing the scale, and special pumping and heating equipment. The heating units were used to raise the temperature of the solvents, thereby increasing the solution rate. The latter was important since it was impossible to shut down the units longer than 24 hours.

The solvent pump discharge was tied into the absorber first in line. Cold solvent was then pumped into the system to establish circulation and to remove air pockets. A few pounds back pressure was held on the discharge to keep the units full. This was necessary to avoid a siphoning effect. As soon as the units were full and a circulation rate of two barrels per minute established, the heating unit on the solvent pump discharge line was cut into the system gradually in order to avoid unnecessary stresses due to sudden temperature rises and the actual treatment began. A check on the effect of the solvent on the equipment was maintained at all times by observing the effect on special metal test strips which were placed at strategic points in the solvent input and discharge lines.

A close check was also maintained on the solvent acidity by titrating samples taken every 30 minutes. Figure 2 shows the solvent acidity loss curve based on titration of the samples. This figure also shows the temperature curve and it will be noted that about four hours' time was required to heat the solvent to a temperature of 170° F. At the end of the four-hour circulating period, the solvent was drained, the unit was flushed and several of the tubes were examined for weight loss. Calibrations of the tubes showed the loss to be immeasurable. An examination of the corrosion strips also verified the observation.

After completion of circulation of the units, they were allowed to cool four hours at which time flushing water was introduced slowly to prevent sudden temperature drops and consequent overstressing of the tube system.

A careful test of the flow rate through the units

TABLE I

	Percent
Silica (SiO_2)	3.6
Gypsum ($CaSO_4$)	Trace
Iron Phosphate	Trace
Iron Chloride	1.2
Ferrous Iron	13.1
Iron Oxide	74.8
Organic Material	7.2
	99.9

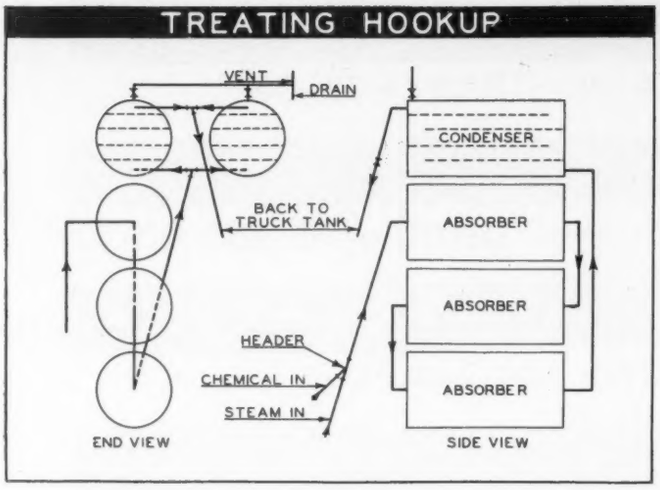


FIGURE 1
Schematic diagram showing hookup for removing scale from refinery equipment.

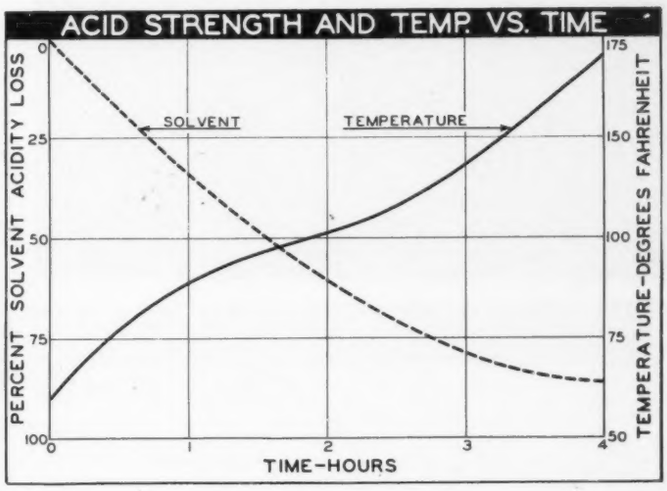


FIGURE 2
Curves plotted from data obtained during treatment show variations in solvent concentration as the temperature of solvent was raised.

was then made and it was found that whereas the rate was 3,200 gallons per minute at 34 pounds pressure drop before treatment, it was 4,000 gallons per minute at 21 pounds pressure drop after treatment. It was found also that it was not necessary to turbine the tubes before putting the units back into service.

No extra labor was necessary to complete the successful chemical removal of the scale deposits, and fire hazards and other ordinary attendant dangers were reduced to a minimum since it was unnecessary to use mechanical types of cleaning equipment. All the scale was removed, leaving no nuclei for new scale formation.

X-Ray Method of Analysis

The key to successful chemical scale removal is the analysis of the scale. Without complete knowledge of the composition of the scale, it is impossible to select the solvent concentration, number and concentrations of addition agents and temperature of the solvent.

As time is always a factor in scale-removal work, analyses of scale samples must be made as quickly as possible. One of the most rapid and economic methods of analyzing scale is by the use of the X-ray.

In his original work on X-ray chemical analysis, Hull[1] stated: "That every crystalline substance gives a pattern; that the same substance always gives the same pattern; and that in a mixture of substances each produces its pattern independently of the other, so that the photograph obtained of a mixture is the superimposed sum of photographs that would be obtained by exposing each of the components separately for the same length of time. This law applies quantitatively to the intensities of the lines as well as to their positions, so that the method is capable of development as a quantitative analysis."

The work of Hanawalt[2] and others in classifying the thousands of different chemical substances so that they may be easily used for the identification of an unknown, even if the unknown is a mixture of substances, has made the use of the Hull method of X-ray analysis of practical and valuable assistance to the chemist and engineer interested in a rapid and economical means of determining the definite identification of foreign compounds such as are encountered in industrial equipment.

The type X-ray apparatus to be used depends upon the kind of data desired and the accuracy necessary. An X-ray laboratory capable of handling all techniques would require a large variety of apparatus. For the purpose of the chemical analysis required in scale-removal work, however, much simpler and more economical aparatus will suffice.

According to Hanawalt, the multiple diffraction unit is a convenient type. (Figure 3.) This unit consists of a transformer, X-ray tube with molybdenum target, and cameras. Twelve slits around the circumference of the cylinder containing the X-ray tube

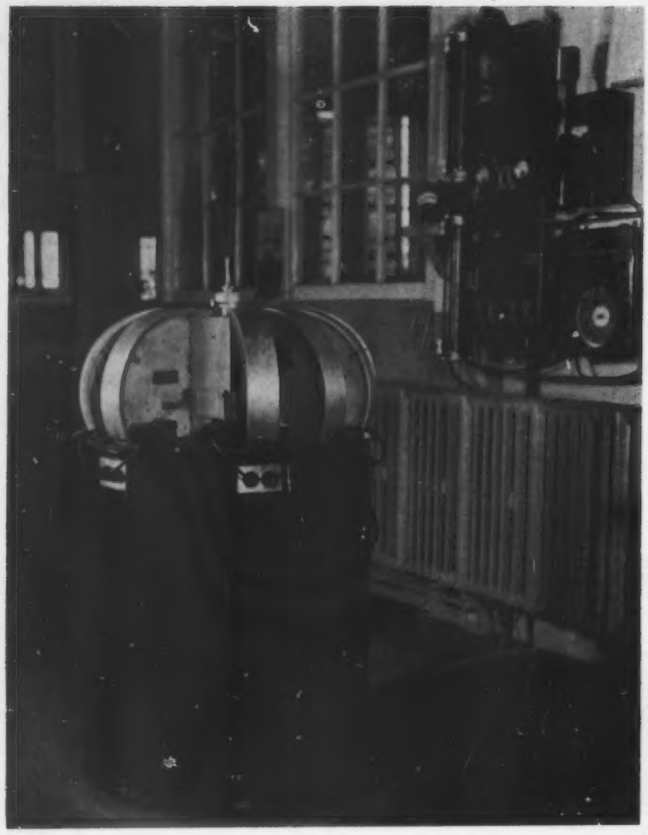


FIGURE 3
The diffraction apparatus is so arranged that 24 X-ray exposures may be made simultaneously.

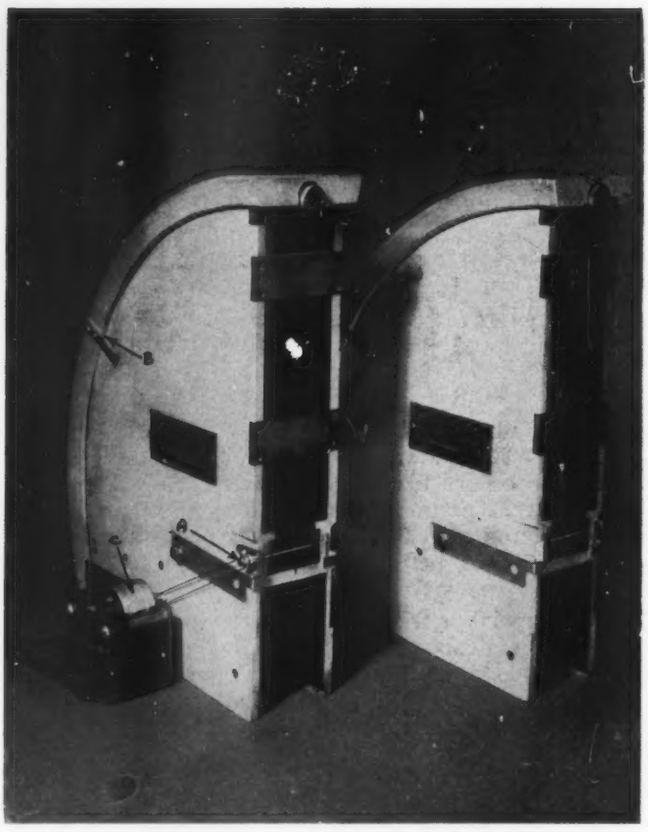


FIGURE 4
Each cossette, or camera, of the X-ray diffraction apparatus is equipped with a small electric motor to turn the sample during exposure.

define the X-ray beams. There is also a switchboard on which are mounted the operating switches, meters, filament current stabilizer, a water-pressure switch, and an overload circuit breaker. In addition to this standard equipment, Hanawalt uses a recording millimeter, which gives a record of the tube current during exposure; a time switch, by which an exposure can be stopped at a predetermined time, and a temperature switch that cuts off the voltage when the cooling-water temperature reaches 100° F.

The specimen tube is inserted in the camera at point "A" in Figure 4; the film is placed in the rear of the camera at point "B," a distance of about eight inches from the tube. A zirconium dioxide filter is placed in front of the film to absorb certain types of radiation and a fluorazure intensifying screen is placed directly behind the film. In order to obtain a more uniform pattern, the specimen tube is rotated during exposure by the motor shown at "C" in Figure 4.

The specimens to be analyzed are loaded in powder form in a Pyrex capillary tube. A plug of cotton is placed in the center of the tube and the samples loaded on either side of the cotton plug for a distance of one cm. After the samples are packed into the tube, another cotton plug is placed in each end of the tube, and the tube sealed in a flame.

After the specimen tube is loaded, it is inserted in

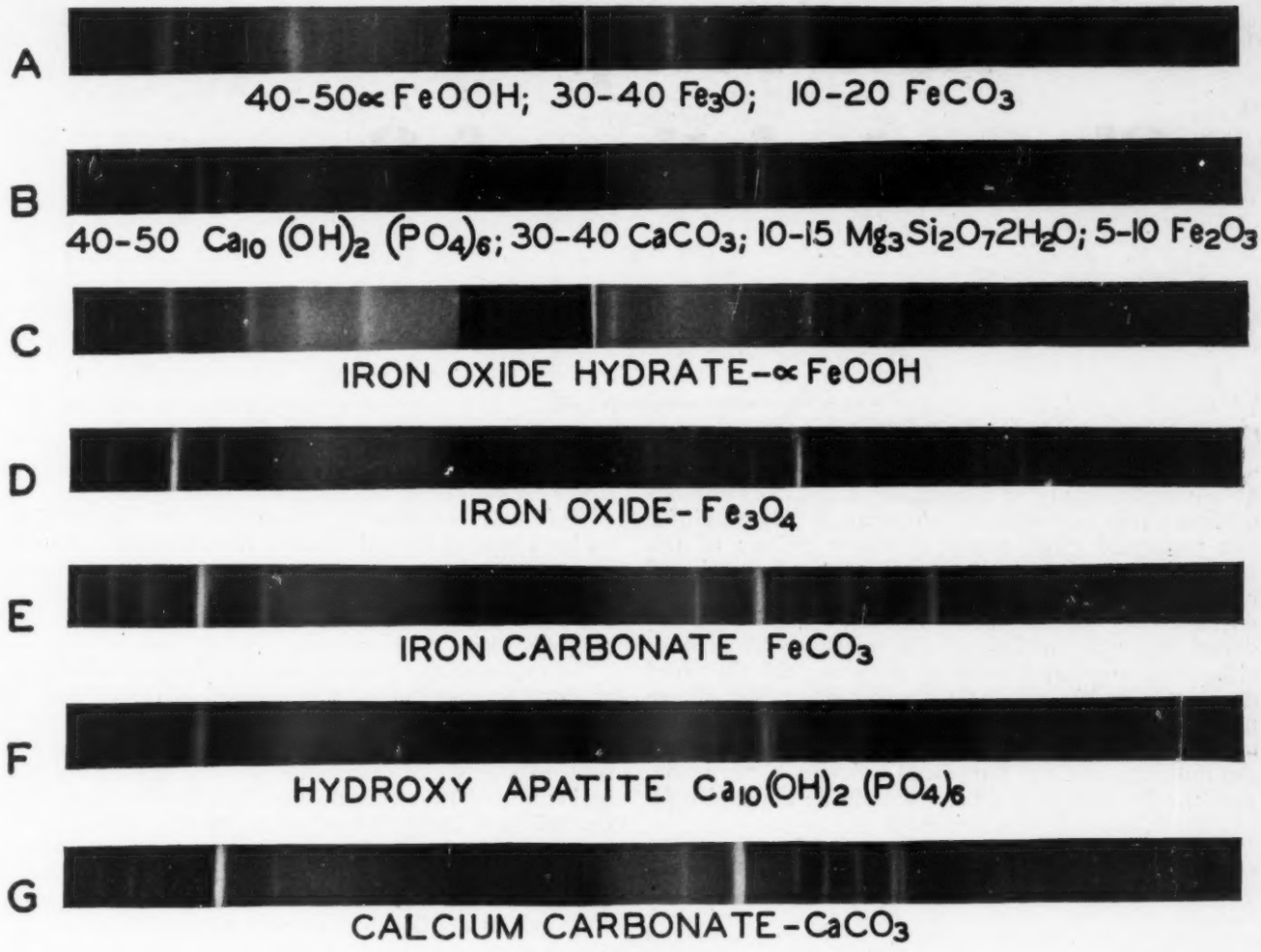


FIGURE 5

Distinctive patterns of scale constituents aid in their identification.

the camera at point "A" (Figure 4). The assembly is then placed on the diffraction unit and exposed for six hours at 30,000 volts and 20 milliamperes. The unit described by Hanawalt and others holds 12 cameras; two specimens can be placed in each tube; thereby making possible the exposure of 24 specimens simultaneously. The development of all the films requires about 1½ hours, and the time for analysis and recording, an additional half-hour per specimen. By using a different type of camera, a pattern can be made in 15 minutes and a complete analysis in less than an hour. This method does not permit the simultaneous exposure of 24 specimens and, therefore, is not very practical except in rare instances.

It is well known that there are definite limitations to the field of application of the X-ray method of analysis, but there is no doubt of its value when used within its proper scope. The method is limited to solids and only to those solids that have a crystalline structure, or in other words, those solids that give a pattern. The only way to determine whether or not an unknown will give a pattern is to X-ray it. Experimental data indicate that about 95 percent of the solid organic chemical substances are crystalline and give a pattern that can be identified.

Other substances give such weak patterns that, although they could be identified if they were the only constituents present, they might escape detection if mixed with something else. Also, appreciable percentages of elements may be present in solid solution without changing the pattern enough to be detected..

An example of the type of patterns obtained by an X-ray analysis is shown in Figure 3. Patterns A and B in this figure have been made from typical boiler scales. To determine the compounds present in these scale samples, it was only necessary to compare their X-ray patterns with standard patterns of pure compounds. The results of this comparison are shown by the chemical analysis in Figure 5, A and B. More specifically the pattern for boiler scale A shows the dominant characteristics of the standard patterns for alpha FeOOH, Fe_3O_4, and $FeCO_3$. Considering the intensity of the lines corresponding to these three standard patterns, it is estimated that the sample contains 40-50 percent OC FeOOH, 30-40 percent Fe_3O_4, and 10-20 percent $FeCO_3$. The analysis for boiler scale B was determined in a similar manner.

BIBLIOGRAPHY

[1] Hull, A. D., A New Method of Chemical Analysis. Jour. Amer. Chem. Soc., Vol. 41, August 1919, pp. 1168-1175.

[2] Hanawalt, J. D., Rinn, H. W., and Frevel, L. K., Chemical Analysis by X-Ray Diffraction. Ind. and Engr. Chem., Vol. 10, No. 9, Sept. 15, 1938, pp. 457-512.

[3] X-Ray Fingerprints Scale Deposits, C. E. Imhoff and L. A. Burkhardt, Power, Jan. 1942, pp. 64-66.

Low Temperature Characteristics of Greases*

THOMAS A. MAXWELL
Chief Chemist, International Lubricant Corporation

THE strategic importance in military operations of an adequate supply of lubricants satisfactory for operation under extremes of temperature and humidity has prompted close study of many phases of the problem. Good lubricating qualities, mechanical and chemical stability at high and low temperatures without oil evaporation or separation, resistance to deterioration by moisture, and minimum change of effective consistency with temperature are the chief desiderata. While generally speaking any one grease might be called upon to function under such extremes of conditions, it is a matter of utmost importance to the military, and has long been a desire of the trade, that the full range of service should be covered by a minimum number of lubricants.

One specific phase of service requiring a special lubricant has been the exposed bearings of military aircraft. These may alternately be roasted under tropical suns and chilled to perhaps 100 degrees below zero on nocturnal flights at high levels.

The study covered in this paper was undertaken as background for fabrication of lubricants suitable for such service, to establish the role of different soap bases and different oil viscosities in determining the behavior of greases in ball-bearing service at low temperatures.

To evaluate the performance of the test lubricants at low temperatures, the torque test outlined in Army-Navy Specification AN-G-3 of May 30, 1942, was used. An eight-ball 204 open bearing was packed with five grams of grease, closed with slip-fit shields, and run in 100 turns each way. The bearing was then chilled on a straight-line curve to test temperature in 2 hours and soaked for 1 hour, rotating two turns every 15 minutes. At the end of the soaking period the time necessary for a complete revolution with 2000 gmcm applied torque was determined.

The apparatus used, shown in Figures 1, 2, and 3, consisted of a cold bath, a block for supporting test bearings, spindles, a fan, thermocouples, and accessories for producing and measuring temperature and torque. The cold bath comprised a cylindrical 1-gallon silvered glass vacuum jug inside a protective wooden case. An oak block 8 inches square and 8 inches long was turned down along 7 inches of its length to a cylinder which fitted loosely into the vacuum jug, that is, about 6 inches diameter. The 8-inch-square top overhanging the cylinder fitted snugly into the outer wooden case flush with its top and rested on an inside shelf so that the block was held in fixed position not touching the jug. This block was drilled for four vertical spindles, symmetrically placed as shown, a centrally placed fan shaft, a small inlet and

* Before the tenth annual meeting of the National Lubricating Grease Institute, New Orleans, October 25 to 29, 1942.

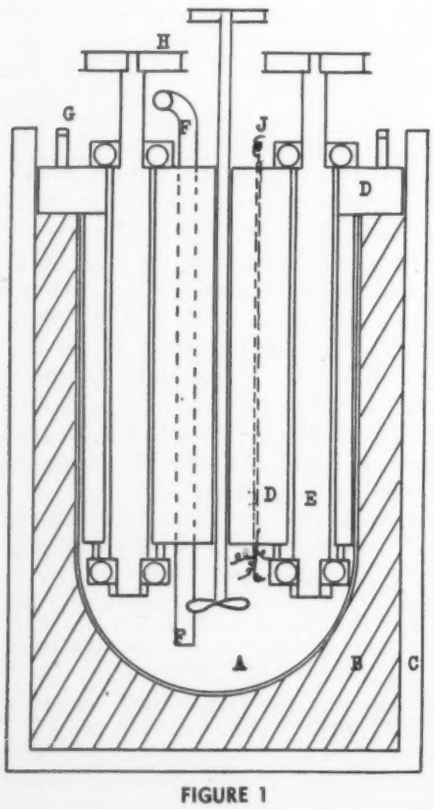


FIGURE 1

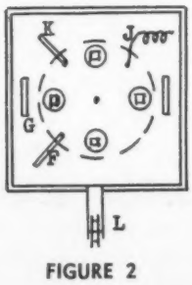


FIGURE 2

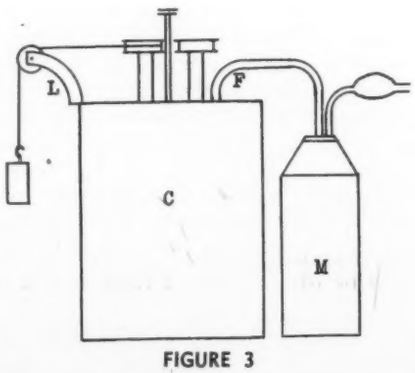


FIGURE 3

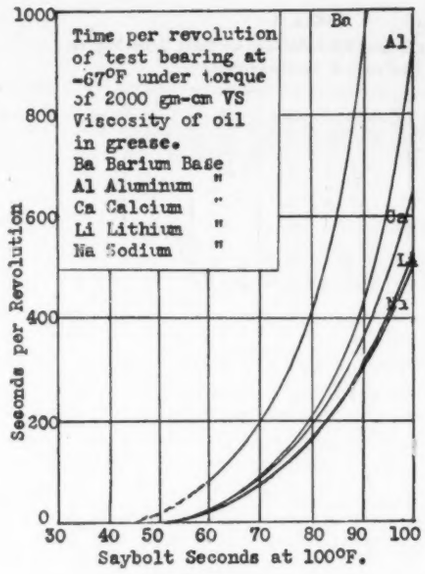


FIGURE 4

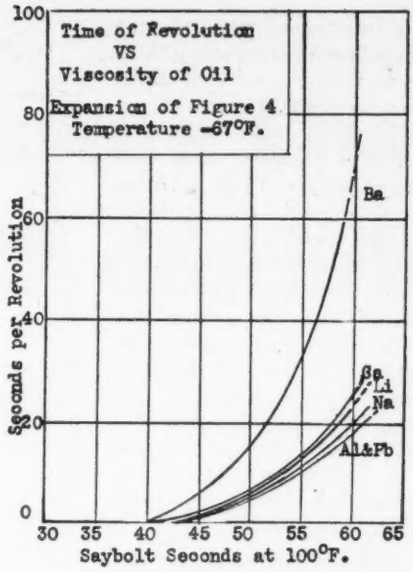


FIGURE 5

outlet for refrigerant, and a tube for thermocouple leads.

Each test bearing was held in place by three steel pins projecting from the block. The outer race of each bearing was notched in one place sufficiently that the pressure of a pin at this point prevented rotation. These pins projected an inch from the block and the bearings were supported ½-inch from the block. The cylindrical spindles were of oak with metal caps at the cold end so threaded that the inner race of the test bearing could be held tight by a lock nut. The upper spindle guide bearing was held permanently in place by large screws and was packed with a very light grease. The top inch of the spindle was square in cross section to accommodate a 4-centimeter pulley with square hole to match. A small glass tube housed the eight thermocouple leads, while two ¼-inch glass tubes served as inlet and outlet for refrigerant. The small fan shaft was housed in a glass tube shrunk to bearing clearances at either end. This was powered first by motor and pulley and then more conveniently by a small air turbine. A portable potentiometer was used to measure the thermocouple voltage, with the usual ice-bath cold junction.

Refrigeration was achieved and controlled manually by admitting small increments of liquid nitrogen directly to the bottom of the cold bath where it immediately boiled to a gas absorbing heat from the air which was swirled rapidly about the bearings. Since the annular spaces about the block and the spindles were sealed at the top, the dead gas space was an effective insulator; the thermal leakage was small in proportion to the thermal capacity; and close control was possible, while the low heat capacity permitted close control of the rate of cooling. The temperature range was limited only by the temperature of liquid nitrogen some 320° F. below zero. For flexibility, range, and freedom from moisture condensation the unit compared most favorably with carbon-dioxide cooled units.

Another piece of apparatus which proved of interest in this study was one patterned after a unit described in the British Air Ministry's Specification DTD 201, "Controls Lubricating Oil." We con-

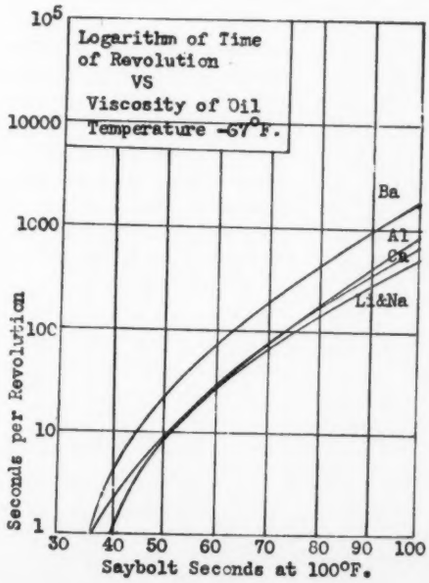


FIGURE 6

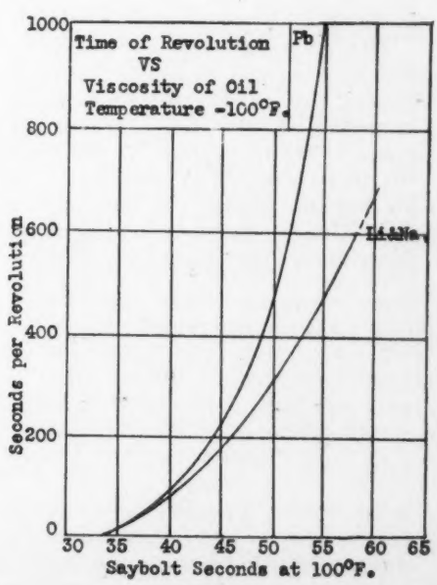


FIGURE 7

structed a modified multiple-bearing unit and did some preliminary work which proved interesting. We discontinued this test, however, in favor of establishing a foundation with the standard test, to which we might later correlate results of the simpler unit.

Our modification consisted of a ½-inch steel ball on the end of a ⅛-inch shaft, seated into a brass socket bearing. The socket was held by a rubber sleeve in the flared end of a glass condenser tube, the upper end of which was shrunk to a bearing fit about the ⅛-inch shaft. A pulley on the shaft above the tube served for applying torque and supporting the loading weights when used. We used four such units mounted vertically through a lid which fitted the cold bath used for the ball bearing test. For coolant we used a liquid bath of acetone chilled with dry ice.

Our preliminary work indicated that the torque characteristics of greases in the range of useful consistencies was of the same order of magnitude as that of the base oil from which they were fabricated.

The lubricants tested in the ball-bearing torque apparatus comprised greases of from 310 to 340 A.S.T.M. worked penetration made from six metallic bases and four base oils. Test samples were prepared as nearly free as possible from fibrous or granular structure and were of anhydrous type. No mixtures were tried. The fatty material used in compounding the greases was not identical in all cases, but was varied according to the requirements of the individual metal bases.

The oil designated as 100 viscosity was a conventionally refined naphthenic stock from a Louisiana crude and had a viscosity index of 25, a flash of 325° F., and a pour of —60° F. The 57-viscosity oil was of similar type, lower in viscosity and flash, with a pour point of —65° F. The 40-viscosity stock was a highly refined stock of 310° F. flash and —65° F. pour. The 34-viscosity oil was a gas oil from a local crude.

For the purpose of this testing the volatility characteristics of such light stocks were not considered. The object was to find the range of stocks suitable from the standpoint of low-temperature performance without regard to other characteristics.

In Table 1 are shown the time of revolution of test bearings at the temperatures indicated. Very high and very low values are to be taken only as indicative of the order of magnitude involved.

The relation between time of revolution and oil viscosity for the various greases at —67° F. is shown graphically in Figure 4. Bearing in mind the inaccuracy of the test measurement for very stiff greases, the dispersion at the higher oil viscosities is not to be taken too literally. With the exception of the barium grease the torque values are similar for the different bases to a degree within the limits of control of manufacture. Figure 5 represents an expansion of a limited area of Figure 4. Since a time of about 30 seconds is the maximum permissible in a satisfactory grease, the use of an oil of viscosity less than about 60 at 100° F. is indicated. For barium greases an even lighter oil might be necessary. Many other factors might play a part in the choice. No tests were run on high-soap-content greases milled down to the desired consistency, nor on fibrous greases. Preliminary tests on Sodium base greases incorporating small amounts of organic esters seemed to indicate that such products were effective for reducing torque only as they reduced the effective oil viscosity. Figure 6 shows the logarithm of the time of revolution plotted against the oil viscosity at 100° F. The nearly linear nature of the curve indicates some logarithmic relationship between torque and viscosity. Figure 7 depicts the relationship between the time of revolution at —100° F. and oil viscosity at 100° F. of three types of grease. The relative unimportance of the metal base in determining torque characteristics is still apparent.

TABLE 1
Time in Seconds for Revolution of Test Bearing at Indicated Temperature

TEMP.	Oil Viscosity Saybolt @ 100°	Aluminum Base	Sodium Base	Lithium Base	Lead Base	Calcium Base	Barium Base
— 67 °F.	100	950	507	535	...	653	1950
— 67 °F.	57	17	17	19	16	22	55
— 67 °F.	40	4	...	<1	<1	...	...
— 67 °F.	34	<1	<1	<1	<1	<1	<1
—100 °F.	57	...	600	600	Frozen	...	...
—100 °F.	40	...	...	85	92	...	...
—100 °F.	34	<1	<1	<1	1	...	1
—120 °F.	34	3½	½	4	...	...	3½
—150 °F.	34	502	182	420	...	...	1300

The four greases tested at —120° F. and —150° F. appear at first glance to be very different in torque characteristics; but, since they were all very satisfactory at —120° F. and there is currently little interest in greases functioning at —150° F., it may be assumed that the limiting oil viscosity for greases satisfactory at —120° F. will be somewhere in the neighborhood of 36 to 40 seconds at 100° F.

In summary it may be stated the low-temperature bearing torque characteristics of greases fabricated from different metal bases and low viscosity index oils appeared to be dependent chiefly on the viscosity of the oil used. Barium greases seemed to stiffen somewhat above the average of the other greases tested.

Since the use of very light oils is dictated by low temperature requirements, part of the problem lies with the refiner to produce stocks of the best possible volatility characteristics for the grease compounder to try his art on. Much work remains to be done in determining the effect of viscosity index, of phenomenal pour points, of blending agents, and of extreme pressure and/or oiliness additives which may be added to light oils.

Vapor-Pressure Chart for Volatile Hydrocarbons

R. VINCENT SMITH
United States Bureau of Mines

WHEN the vapor of a single component liquid is exposed to "free" space above it there is a continuous movement of the molecules of the liquid from the surface of the liquid into the "free" space, and at the same time a continuous passing of molecules of the vapor into the liquid. If these two phenomena exactly balance one another, the liquid and its vapor will be in equilibrium, and the vapor will be saturated with liquid. The resultant pressure exerted by the saturated vapor is known as its vapor pressure.

Vapor pressures of single-component liquids are independent of the quantities of vapor or liquid in equilibrium but vary with temperature, and for every temperature below the critical pressure a definite pressure is exerted by a vapor in equilibrium with liquid.

Many vapor-pressure charts have as their basis the coordinates (logarithm of vapor pressure and reciprocal of absolute temperature) suggested by an integrated form of the Clausius-Clapeyron equation (a derivation of the equation is given by Getman and Daniels[22]), which is as follows:

$$\log p = -\frac{A}{T} + B,$$

where p = vapor pressure,
T = absolute temperature, and
A and B = constants.

Experimental data, however, do not yield straight lines when plotted upon this basis but yield curves in which the curvature is small throughout their extent. Consequently, the logarithm of pressure and the reciprocal of absolute temperature were chosen as coordinates for a convenient graphic means for presenting data on vapor pressures of hydrocarbons.

A vapor-pressure chart using a special nonuniform temperature scale has been suggested by Cox[16] in an effort to present vapor-pressure data as straight lines. The coordinates of the chart are the logarithm of vapor pressure and a temperature scale obtained by drawing a straight line on semilogarithmic paper and allowing the line to be the vapor-pressure curve of some substance whose vapor pressures are known accurately. The temperature scale is determined by using the logarithm of the pressure to locate corresponding temperature points.

Description of a Vapor-Pressure Chart

In the construction of the accompanying vapor-pressure chart, collected data were plotted on semilogarithmic coordinate paper, on which the ordinate is the logarithm of vapor pressure and the abscissa is the reciprocal of degrees Kelvin (degrees centigrade absolute). As finally drawn, the vertical lines in the body of the chart represent degrees centigrade, and for extra convenience a Fahrenheit-temperature scale has been placed at the top of the chart. To facilitate use of the chart in low-temperature distillation analyses, a millivolt scale has been provided for users of 3-element copper-constantan thermocouples. The data required to construct the temperature scale, labeled millivolts for 3-element copper-constantan thermocouple, were taken from the International Critical Tables.[25] Although the values taken from the tables are arbitrary, matched-couple pairs may be obtained that will permit using the supplemental scale. For precise work, each individual thermocouple should be calibrated to determine individual deviations from this scale.

The pressure and temperature ranges covered by the chart provide space for plotting the vapor pressures of all the hydrocarbons up to n-dodecane ($n\text{-}C_{12}H_{26}$), with the exception of pressures for methane below 15 millimeters of mercury. The inset at the upper right of the chart has an expanded temperature scale, so that the isomers of hexane and heptane could be shown more clearly than on the main chart. Available data for the isomers of hexane and heptane are relatively incomplete, and only the normal boiling-point data were found in the literature. Accordingly, dashed curves are used where data were extrapolated.

Numerous equations for calculating vapor pressures were found in the literature, and in general the equations yielded results that agreed with the experimental data over narrow ranges of pressure; over more extensive pressure ranges the results seldom

COMPILATION of this vapor-pressure chart grew out of studies on the physical properties of petroleum and natural gas at the experimental station of the United States Bureau of Mines, Bartlesville, Oklahoma. The necessity of frequent references to the literature prompted the decision to compile the chart.

The compilation has been printed as Bureau of Mines Information Circular 7215.

The investigation was made under the supervision of R. A. Catlell, chief engineer, petroleum and natural gas division, Washington; and N. A. V. Smith, supervising engineer at the Bartlesville station, and under the direct supervision of Kenneth Eilerts, physical chemist, and R. E. Heithecker, senior petroleum engineer, Bartlesville.

The vapor-pressure chart was prepared by S. B. Thomas. Other staff members mentioned by the author are E. S. Burnett, C. B. Carpenter, H. C. Miller, M. A. Scheihardt and Gustav Wade.

agreed with the experimentally determined data, and for that reason vapor pressures calculated by means of equations were not used in constructing the accompanying chart.

Each averaging curve on the chart was drawn so that its shape was similar to that of the adjacent curves. Normal boiling-point data given by Egloff,[21] which are weighted averages of all available experimental data, were given the most consideration in determining the position of the curves. Many of the data for pressures above 1,000 millimeters of mercury were taken from Tables *anuelles de constantes et donnees numeriques*[44] and from work by Young,[48] who published the original data in connection with a study of the boiling points of the normal paraffin hydrocarbons. The close agreement between these and other data in the low-pressure range and data at higher pressures from other sources indicated that considerable weight could be given those data in determining the position of the averaging curves at high pressures.

The data available for determining the greater part of curves for methane,[1, 19, 21, 24, 28, 36, 44, 48] ethylene,[12, 14, 19, 21, 24, 27, 28, 32, 33, 36, 44] and ethane[1, 6, 10, 12, 14, 19, 21, 23, 24, 26, 28, 31, 32, 33, 35, 36, 37, 44, 48] were in close agreement. It was necessary, however, to extend the curves to low pressures, and the extrapolations (dashed part of the curves) were drawn to conform in shape with the adjacent curves.

There was good agreement among the published data for propylene (propene)[13, 14, 19, 21, 24, 27, 28, 33, 36, 38, 45] from different sources for pressures above 1000 millimeters of mercury, and the curve for propylene was drawn parallel to the curve for propane, even though the curve did not pass through all the data points in the low-pressure range. Published data for propane[1, 8, 13, 14, 17, 19, 21, 23, 24, 28, 33, 36, 44, 48] do not agree exactly, and small differences were noted in the pressure range below 1000 millimeters of mercury. The trend of the data, however, was consistent, and it was possible to draw a curve for propane with its position fixed within the limit of probable experimental errors.

The available data for insobutane (methyl-propane)[2, 14, 15, 17, 19, 21, 23, 24, 28, 36, 38] between mercury pressures of 300 and 760 millimeters were inconsistent in trend but regular at higher and lower pressures. Consequently, the averaging curve was drawn giving the least weight to data in the intermediate pressure range.

Two distinct curves for pressures greater than 1000 millimeters of mercury were obtained when the data for n-butane[1, 4, 9, 13, 14, 15, 17, 19, 21, 23, 24, 28, 36, 38, 44, 48] were plotted. As the curve determined by the data reported by Young[48] conformed to data from other sources in the low-pressure range, the curve shown on the chart was drawn through one set of data without giving consideration to the other set.

The available vapor-pressure data for neopentane (2,2-dimethylpropane)[3, 19, 21, 43, 46] are complete only in the pressure range from 100 to 1000 millimeters of mercury, and although there are small differences between the values from the five sources, they are small and of the magnitude of experimental errors. The neopentane curve was extrapolated in both directions so as to correspond in shape with adjacent curves for n-butane and isopentane. The values of the critical constants for neopentane reported by Doss[19] and originally published by Standard Alcohol Company[43] are close to those of isopentane. Consequently, they do not conform to the trend of the vapor-pressure data, and it was concluded that an error exists either in the vapor-pressure data or in the critical pressure and temperature data, or in both. As the vapor-pressure data for neopentane are from two sources that are in agreement, more confidence can be placed in the vapor-pressure data than in the reported critical-pressure and temperature data.

Published data for isopentane,[19, 21, 24, 28] n-pentane,[1, 19, 21, 24, 28, 39, 44, 47, 48] n-hexane,[1, 19, 21, 24, 28, 29, 39, 42, 44, 47, 48] n-heptane,[1, 7, 11, 19, 20, 21, 24, 26, 28, 29, 34, 39, 41, 42, 44, 47, 48] and n-octane[1, 19, 21, 24, 28, 29, 30, 39, 44, 47, 48] agree and permit determining the positions of the averaging curves with little doubt as to their correct position on the chart.

Most of the available data for n-nonane, n-decane, n-undecane, and n-dodecane were published by Young,[48] and curves drawn through the plotted data are regular, consistent in trend, and agree with those based on data from other sources—(n-nonane[1, 19, 21, 39, 44, 47, 48]), (n-decane[1, 19, 21, 28, 30, 39, 44, 47, 48]), (n-undecane[1, 19, 21, 39, 44, 47, 48]), and (n-dodecane[5, 19, 21, 39, 44, 47, 48]).

The data on critical pressures and temperatures compiled by Doss[19] and Pickering[36] were used in the work reported here, as they were consistent with other data except for those given for 2,2-dimethylpropane (tetramethylmethane or neopentane) and n-decane.

The inset at the upper right of the chart is a plot of the available data for the insomers of hexane[11, 19, 21, 24, 28] and heptane.[11, 19, 20, 21, 40] Data for 2,2-dimethylbutane,[11, 19, 21, 24, 28] 2,3-dimethylbutane,[11, 19, 21, 2,2,3-trimethylbutane,[11, 19, 20, 21, 40] and 3-ethylpentane,[11, 19, 20, 21] are complete between pressures of 100 and 1000 millimeters of mercury but incomplete for the other isomers. Certain curves, therefore, have been indicated on the chart by dashed lines approximately parallel to the curves for closely related components on which complete data were available.

Conclusion

The vapor-pressure chart (accompanying this report) of many volatile, naturally occurring hydrocarbons was prepared from data gleaned from a long list of references. The search of the literature revealed that vapor-pressure data are complete for the normal hydrocarbons up to and including n-decane (n-$C_{10}H_{22}$), with the exception of n-nonane (n-C_9H_{20}). Vapor-pressure data are incomplete for isopentane below pressures of 50 millimeters of mercury. The available critical constants for neopentane are apparently in error, and the vapor-pressure data, when plotted on the chart, yield 2 lines with slightly different slopes. Data for isobutane are inconsistent in trend between pressures of 300 and 760 millimeters of mercury.

Need exists for a set of empirical equations that have been fitted to experimental data and that would permit accurate calculation of vapor-pressure extrapolations and interpolations over the entire range of pressures. Such a set of equations would "round out" present knowledge of vapor pressures of hydrocarbons.

The accompanying vapor-pressure chart has been

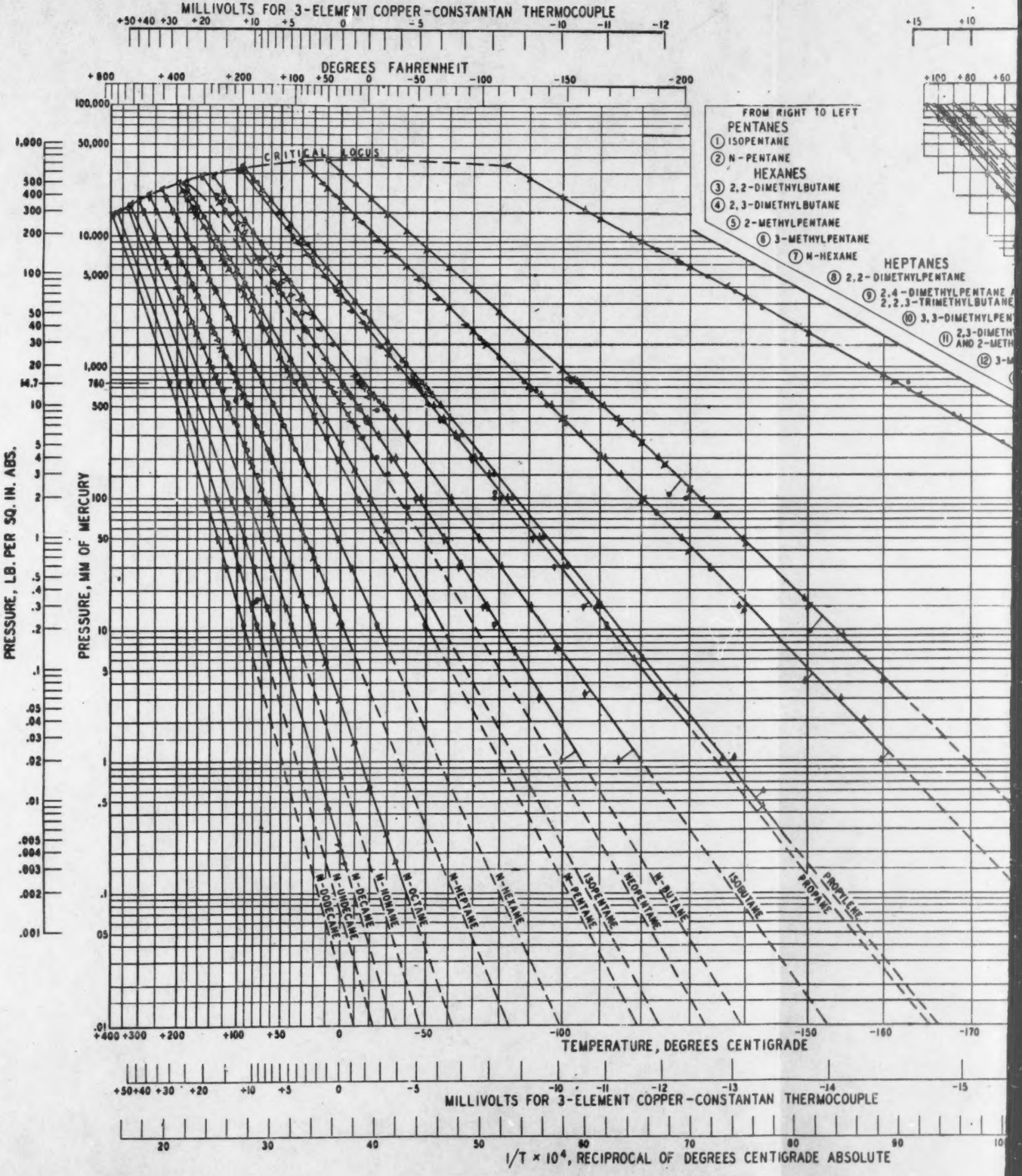
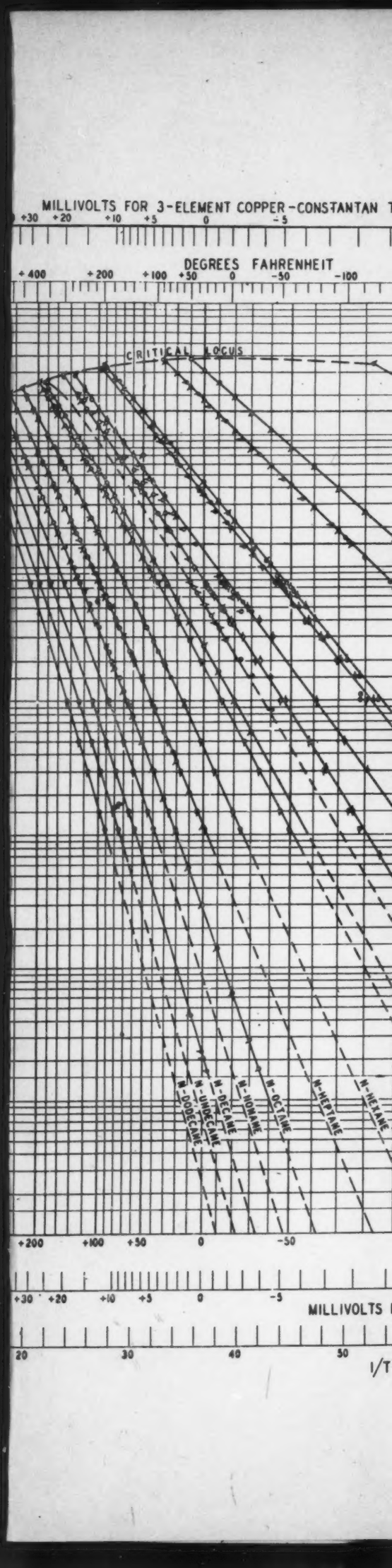


FIGURE 1
Vapor Pressures of Hydrocarbons


MILLIVOLTS FOR 3-ELEMENT COPPER-CONSTANTAN
+30 +20 +10 +5 0 -5
DEGREES FAHRENHEIT
+400 +200 +100 +50 0 -50 -100
CRITICAL LOCUS
N-DODECANE
N-UNDECANE
N-DECANE
N-NONANE
N-OCTANE
N-HEPTANE
N-HEXANE
+200 +100 +50 0 -50
+30 +20 +10 +5 0 -5
MILLIVOLTS
20 30 40 50
1/T

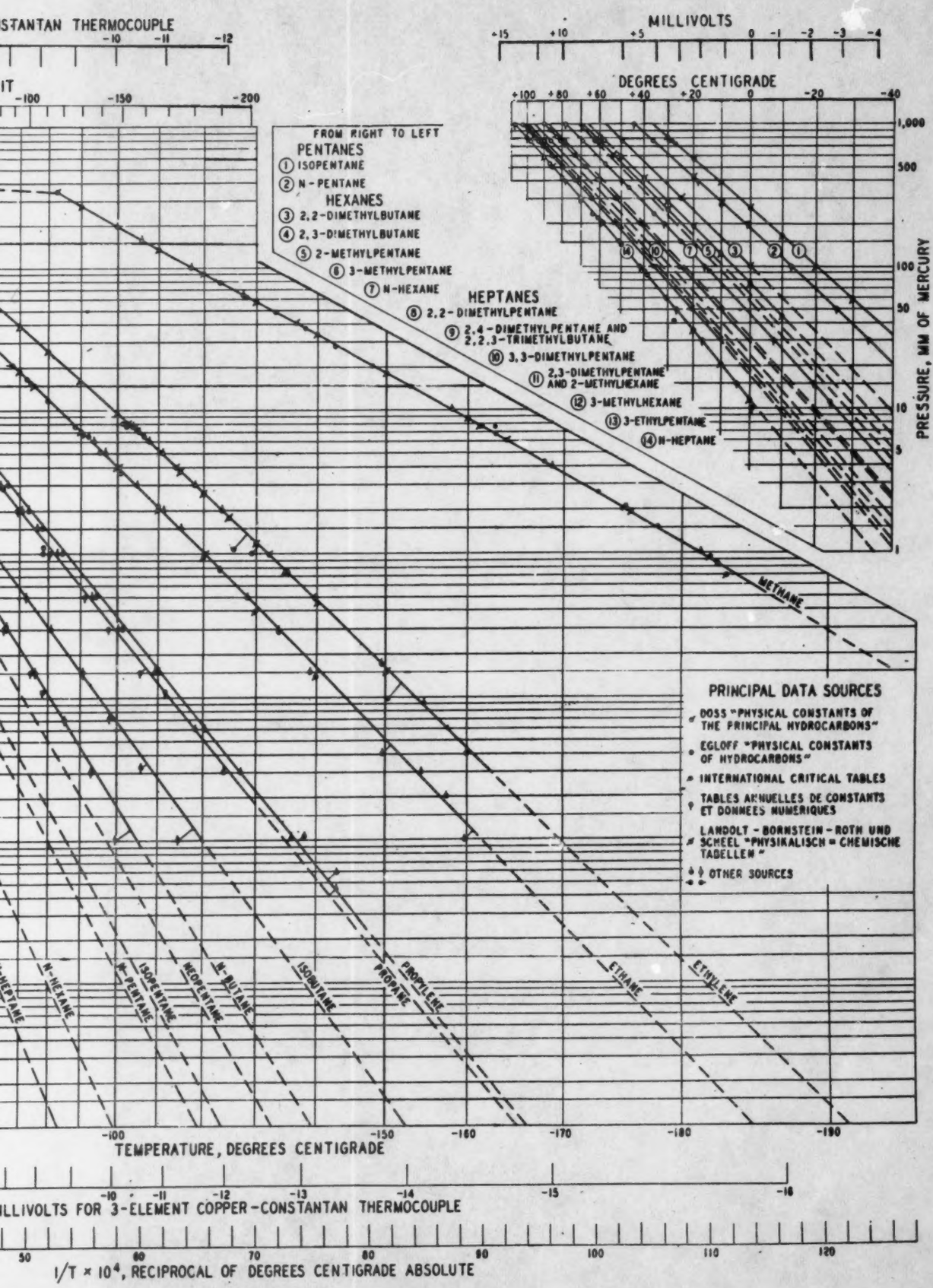


FIGURE 1
Vapor Pressures of Hydrocarbons

useful in distillation procedures where pressures and temperatures vary over wide ranges. The chart has been used successfully to determine "cut points" for distillations at pressures above atmospheric and for distillations at pressures below 50 millimeters of mercury.

BIBLIOGRAPHY

[1] Anderson, R. P. Gasoline from Natural Gas. I. Method of Removal. Ind. Eng. Chem., vol. 12, June 1920, p. 548 .

[2] Aston, J. G., Kennedy, R. M., and Schumann, S. C. The Heat Capacity and Entropy, Heats of Fusion and Vaporization, and the Vapor Pressure of Isobutane. Jour. Am. Chem. Soc., vol. 62, August 1940, p. 2061.

[3] Aston, J. G., and Messerly, G. H. Heat Capacities and Entropies of Organic Compounds. II. Thermal and Vapor-Pressure Data for Tetramethylmethane from 13.22°K. to the Boiling Point. The Entropy from Its Raman Spectum. Jour. Am. Chem. Soc., vol. 58, December 1936, p. 2358.

[4] ———. The Heat Capacity and Entropy, Heats of Fusion and Vaporization, and the Vapor Pressure of n-Butane. Jour. Am. Chem. Soc., vol. 62, August 1940, p. 1918.

[5] Beale, E. S., and Docksey, P. A Wide-Range Boiling-Point Conversion Chart for Hydrocarbons and Petroleum Products. Jour. Inst. Petrol. Technol., vol. 21, 1935, p. 866.

[6] Beattie, J. A., Hadlock, Canfield, and Poffenberger, Noland. The Compressibility of and an Equation of State for Gaseous Ethane. Jour. Chem. Phys., vol. 3, February 1935, p. 95.

[7] Beattie, J. A., and Kay, W. C. The Normal Boiling Point and Critical Constants of Normal Heptane. Jour. Am. Chem. Soc., vol. 59, September 1937, pp. 1586-1587.

[8] Beattie, J. A., Poffenberger, Noland, and Hadlock, Canfield. The critical Constants of Propane. Jour. Chem. Phys., vol. 3, February 1935, pp. 96-97.

[9] Beattie, J. A., Simard, G. L., and Su, Gouq-Jen. The Vapor pressure and Critical Constants of Normal Butane. Jour. Am. Chem. Soc., vol. 61, January 1939, pp. 25-26.

[10] Beattie, J. A., Su, Gouq-Jen, and Simard, G. L. The Critical Constants of Ethane. Jour. Am. Chem. Soc., vol. 61, April 1939, pp. 924-925.

[11] Brooks, D. B., Howard, F. L., and Crafton, Jr., H. C. Physical Properties of Some Purified Aliphatic Hydrocarbons. Nat. Bureau of Standards Jour. Research, vol. 24, January 1940, pp. 43-44.

[12] Burrell, G. A., and Robertson, I. W. The Vapor Pressure of Ethane and Ethylene at Temperatures Below Their Normal Boiling Points. Jour. Am. Chem. Soc., vol. 37, August 1915, p. 1899.

[13] ———The Vapor Pressures of Propane, Propylene and Normal Butane at Low Temperatures. Jour. Am. Chem. Soc., vol. 37, September 1915, pp. 2191-2192.

[14] ———. Vapor Pressures of Various Compounds at Low Temperatures. Bureau of Mines Tech. Paper 142, 1916, 32 pp.

[15] Coffin, C. C., and Maas, O. The Preparation and Physical Properties of Alpha, Beta, and Gamma Butylene and Normal and Isobutane. Jour. Am. Chem. Soc., vol. 50, May 1928, p. 1433.

[16] Cox, E. R. Pressure-Temperature Chart for Hydrocarbon Vapors. Ind. Eng. Chem., vol. 15, June 1923, pp. 592-593.

[17] Dana, L. I., Jenkins, A. C., Burdick, J. N., and Timm, R. C. Thermodynamic Properties of Butane, Isobutane, and Propane. Refrig. Eng., vol. 12, June 1926, pp. 387-405.

[18] Deschner, W. W., and Brown, G. G. P-V-T Relations for Propane. Ind. Eng. Chem., vol. 32, June 1940, p. 837.

[19] Doss, M. P., Physical Constants of the Principal Hydrocarbons. New York, 2d ed., 1939, pp. 1-7.

[20] Edgar, Graham, Calingaert, George, and Marker, R. E. The Preparation and Properties of the Isomeric Heptanes. Part I. Preparation. Jour. Am. Chem. Soc., vol. 51, May 1929, p. 1488.

[21] Egloff, Gustav, Physical Constants of Hydrocarbons. New York, vol. 1, 1939, pp. 1-81.

[22] Getman, F. H., and Daniels, Farrington. Outlines of Theoretical Chemistry. New York, 6th ed., 1937, pp. 126-129.

[23] Handbook of Butane-Propane Gases. Los Angeles, 2d ed., 1935, p. 8.

[24] International Critical Tables. New York, vol. 3, 1928, pp. 216-245.

[25] ———. New York, vol. 1, 1928, p. 58.

[26] Kay, W. B. Liquid-Vapor Phase Equilibrium Relations in the Ethane-n-Heptane System. Ind. Eng. Chem., vol. 30, April 1938, pp. 461-463.

[27] Lamb, A. B., and Roper, E. E. The Vapor Pressures of Certain Unsaturated Hydrocarbons. Jour. Am. Chem. Soc., vol. 62, April 1940, p. 809.

[28] Landolt-Bornstein-Roth und Scheel. Physicalisch-chemische Tabellen. Berlin, vol. 2, 1923, pp. 1354-1357.

[29] Leslie, E. H., and Carr, A. R. Vapor Pressure of Organic Solutions. Ind. Eng. Chem., vol. 17, August 1925, p. 814.

[30] Linder, E. G. Vapor Pressures of Some Hydrocarbons. Jour. Phys. Chem., vol. 35, February 1931, pp. 531-535.

[31] Loomis, A. G., and Walters, J. E. The Vapor Pressure of Ethane Near the Normal Boiling Point. Jour. Am. Chem. Soc., vol. 48, August 1926, pp. 2053-2054.

[32] Maas, O., and McIntosh, D. Some Physical Properties of Ethane, Ethylene and Acetylene. Jour. Am. Chem. Soc., vol. 36, April 1914, p. 740.

[33] Maas, O., and Wright, C. H. Some Physical Properties of Hydrocarbons Containing Two and Three Carbon Atoms. Jour. Am. Chem. Soc., vol. 43, May 1921, p. 1102.

[34] Matthews, J. H. The Accurate Measurement of Heats of Vaporization of Liquids. Jour. Am. Chem. Soc., vol. 48, March 1926, p. 575.

[35] McMillan, W. A. An Azeotropic Mixture of Acetylene and Ethane at Atmospheric Pressure. Jour. Am. Chem. Soc., vol. 58, August 1936, p. 1345.

[36] Pickering, S. F. A Review of the Literature Relating to the Critical Constants of Various Gases. Nat. Bur. of Standards Scientific Papers, vol. 21, S541, 1926-27, p. 629.

[37] Porter, Frank. The Vapor Pressures and Specific Volumes of the Saturated Vapor of Ethane. Jour. Am. Chem. Soc., vol. 48, August 1926, p. 2058.

[38] Seibert, F. M., and Burrell, G. A. The Critical Constants of Normal Butane, Isobutane, and Propylene and Their Vapor Pressures at Temperatures Between 0°C. and 120°C. Jour. Am. Chem. Soc., vol. 37, December 1915, p. 2691.

[39] Shepard, A. F., Henne, A. L., and Midgley, T., Jr. Physical Properties of the Normal Paraffin Hydrocarbons, Pentane to Decane. Jour. Am. Chem. Soc., vol. 53, May 1931, p. 1951.

[40] Smith, E. R. Boiling Points of Benzene, 2,2,3-Trimethylbutane, 3-Ethylpentane, and 2,2,4,4-Tetramethylpentane Within the Range 100 to 1500 Millimeters of Mercury. Nat. Bureau of Standards Jour. Research, vol. 26, February 1941, p. 134.

[41] ———. Boiling Points of n-Heptane and 2,2,4-Trimethylpentane Over the Range 100 to 1500 Millimeter Pressure. Nat. Bureau of Standards Jour. Research, vol. 24, March 1940, pp. 233-234.

[42] Smyth, C. P., and Engel, E. W. Molecular Orientation and the Partial Vapor Pressures of Binary Mixtures. I. Systems Composed of Normal Liquids. Jour. Am. Chem. Soc., vol. 51, September 1929, p. 2649.

[43] Standard Alcohol Co. Properties of Hydrocarbon Gases. November 1937.

[44] Tables Annuelles de Constantes et Donnees Numeriques, 1927-28. Paris, vol. 8, 1931, pp. 249-250.

[45] Vaughn, W. E., and Graves, N. R. P-V-T Relations of Propylene. Ind. Eng. Chem., vol. 32, September 1940, p. 1254.

[46] Whitmore, F. C., and Fleming, G. H. Preparation of Tetramethylmethane (Neopentane) and Determination of Its Physical Constants. Jour. Am. Chem. Soc., vol. 55, September 1933, p. 3806.

[47] Wilson, R. E., and Bahlke, W. H. The Physical Properties of the Paraffin Hydrocarbons. Ind. Eng. Chem., vol. 16, February 1924, p. 119.

[48] Young, Sidney. On the Boiling Points of the Normal Paraffins at Different Pressures. Proc. Roy. Irish Acad., Section B, April 1928, pp. 65-92.

Effect of High Pressure Extrusion on The Adsorption Capacity of Floridin

R. C. AMERO, Assistant Technical Director
R. G. CAPELL, Technical Director, Floridin Company

FLORIDIN fuller's earth, a unique gray-blue siliceous clay occurring in the Hawthorn formation[1] in Gadsden County, Florida, and Decatur County, Georgia, has since 1896 been widely used as an oil refining medium, both in this country and abroad. It has been the subject of many investigations and publications. Notable among these are those of Engler,[2] Hefter,[3] Gurwitsch,[4] Lebedew,[5] Kerr,[6] Nutting[7] and de Lapparent.[8]

Floridin has received intensive study in many fields of inquiry and its application is broadening; however, its largest and most important use has continued to be as a granular refining agent for lubricating oil.

During recent years, the volume used has decreased due to several factors. Most important of these are the introduction of Wedge and Herreshoff burners, activated bauxites, contact adsorbents, solvent refining, general improvement in refining processes, and the improved quality of Floridin itself.

Under the pressure of these competitive forces, the fullers earth industry has continually sought methods of improving the quality of its product. Until 1936 and the introduction of extrusion on a commercial scale, little or no progress had been made in this direction. Figure 1 shows the trend of quality from the year 1930 through 1940 for one producer. Each point represents the year's average of daily quality tests carried out by methods previously described.[9, 10, 11] Briefly, this test is carried out by filtering a solution of steam-refined stock in naphtha through a bed of fullers earth under carefully controlled conditions and measuring the volume of solution filtered to a given color as an index of the quality of the fullers earth The volume of solution filtered through an arbitrarily selected standard earth is taken as a yield of 100 percent, and the efficiency of other samples is rated accordingly. The sharp increase in adsorption capacity after 1935 was largely due to extrusion. By 1940 the adsorption capacity had been increased by 30 percent, which meant that a percolation filter house using this material had its capacity increased by this much without any change in equipment or operation. The hardness of the fullers earth granule is preserved, yet the adsorption capacity is increased. All mesh classifications of ex-

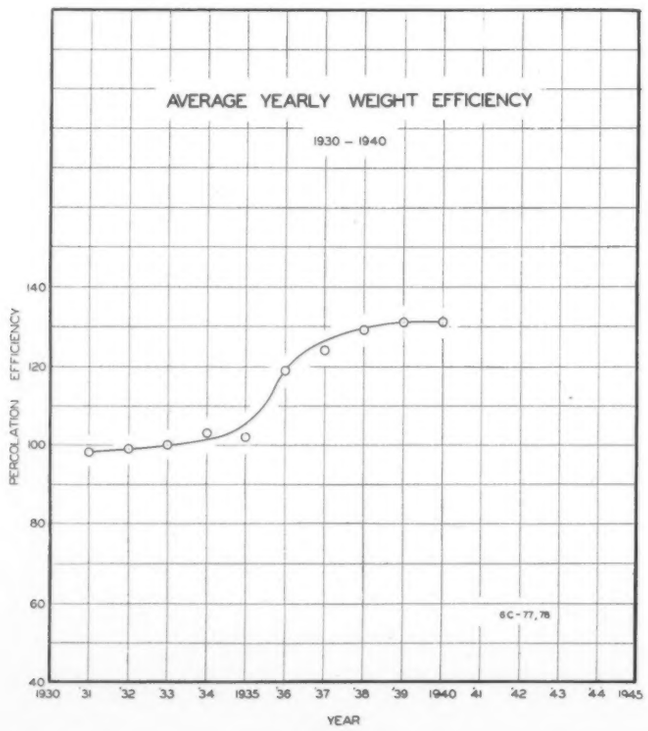


FIGURE 1

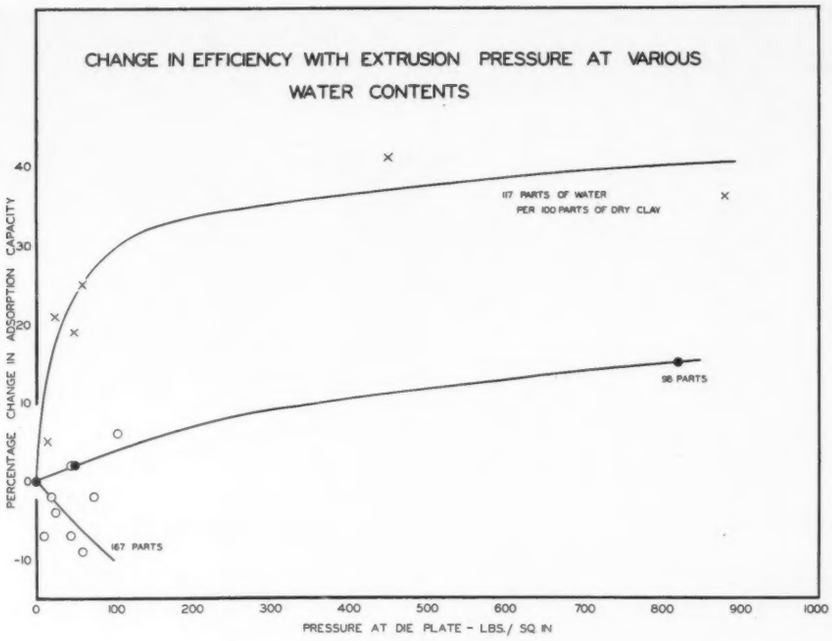


FIGURE 2

truded and unextruded samples appear to the eye to be identical amorphous aggregates since the change takes place internally. This is achieved without the use of chemicals of additions of any sort.

Another factor of commercial value in the extrusion process has been the improvement in the uniformity of the extruded product as compared with the unextruded crude. The reason for this will be found in Figure 6. Note that lower grade crudes give the greatest response to extrusion. For instance, with a selection of crude fullers earth feed of 110 percent efficiency or better ranging up to 125 percent, the limits of efficiency are raised and narrowed to 128-133 percent.

When the fullers earth declines in capacity to 50 percent after 10 to 20 regenerations, depending upon the efficiency of the operation, it no longer pays to use it and it is therefore discarded. A 30 percent increase consequently results in a 60 percent increase in value to the refiner over this discarding point. Thus, it is seen that the extrusion process has brought a real and economically important improvement of great value to the oil-refining industry. Furthermore, the effects induced in the clay body by high-pressure extrusion are of fundamental significance from the standpoint of the physical structure and properties of clays in general, and consequently, the process will no doubt be of interest to all who deal with adsorbent or bleaching clays.

Laboratory Investigation

Hartshorne[12] discovered that an increase in the adsorption capacity of Floridin of as much as 40 percent could be obtained by extruding a pugged mixture of the crude clay and water through a die at pressures up to 500 pounds per square inch. Figure 2 shows how this effect varies with water content and pressure as determined with a small laboratory extrusion machine pictured in Figure 3. Pressures were measured by the use of calibrated springs mounted on the machine as shown in Figures 3 and 4. The procedure was to start the extrusion with complete compression of the spring; then, when a measurement was to be made, the pressure was gradually relieved until the force from the compressed spring just balanced the extrusion pressure. The amount of compression of the spring necessary to achieve this was taken to be a direct measure of the extrusion pressure at the die.

The laboratory extruder proper is a Quaker City auger machine of the familiar meat grinder type. The large scale plant machine operates on the same principle, being a reinforced adaptation of the Chambers Brothers Royal auger brick making extruder.

Effects of Extrusion on Floridin

Grim[13] has described the mineral Floridin and the changes which take place in the clay body during extrusion as follows:

"The clay mineral occurs in flake-shaped particles which are at about the lower limit of visibility (1 micron) or smaller. The clay is actually an aggregation of flakes of the clay mineral. In the sample studied, the flakes occur with a definite fixed uniform orientation, i.e., each flake rests on top of another so that the plane containing its two large axes is parallel to the same plane in the overlying and underlying flakes. The flakes may vary from the true parallel by about 10 degrees.

"From a crystallographic point of view . . . the particles are oriented so that their c axes are parallel. Their b and a axes are approximately parallel, but vary considerably more than 10 degrees from the true parallel.

"This textural characteristic is very well shown in the thin sections by the optical phenomenon. For example, when the section cut at right angles to the

TABLE 1

Effect of Extrusion on Base Exchange Capacity of Floridin

	Millequivalents per 100 grams	
	Unextruded Floridin	Extruded Floridin
Total exchange capacity	20.4	24.3
Exchangeable Mg^{++}	8.0	11.0
Exchangeable K^{+}	1.0	1.8
Exchangeable Na^{+}	1.6	1.8
Less alkali blank	—.9	—.9
Ca^{++} (by difference)	10.7	10.6

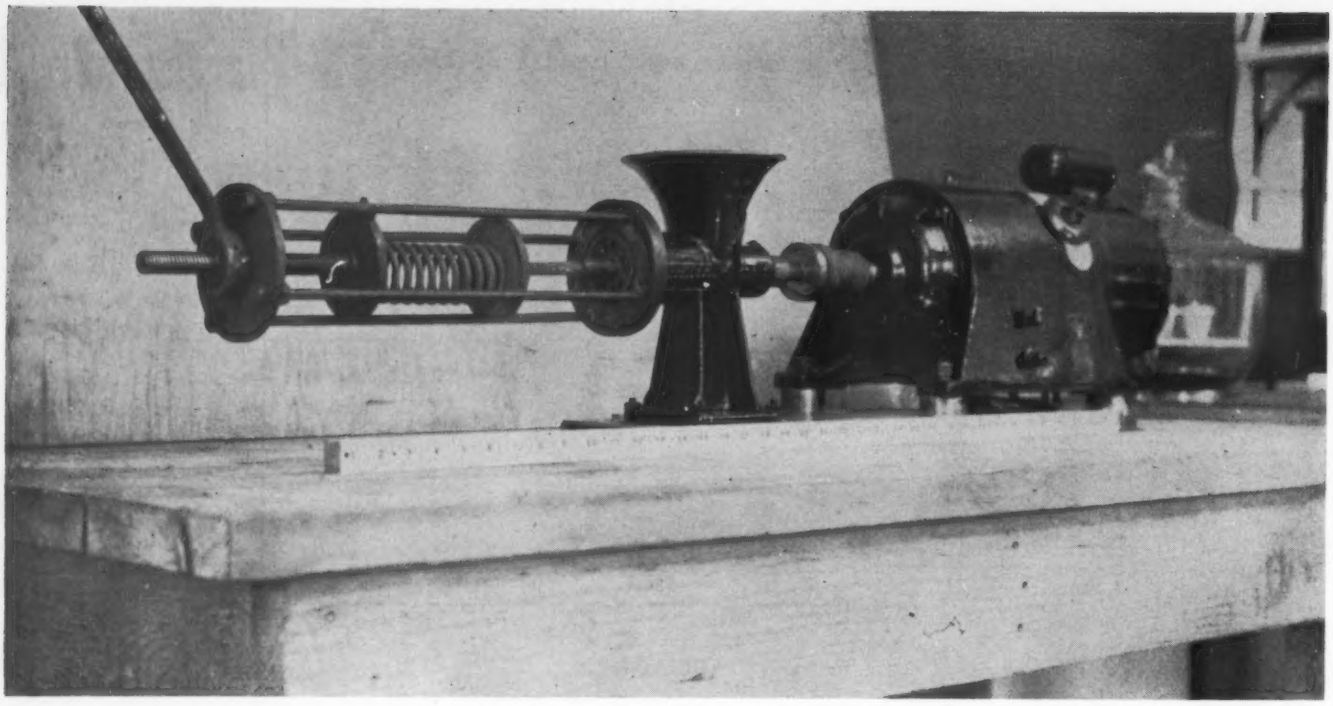


FIGURE 3

bedding is rotated on the stage of the microscope between crossed-nicols, the whole section appears to be composed of one single crystal. It becomes extinct and attains a high birefringent color as would a single section of a micaceous mineral."

Speaking of the extruded clay, he says:

"Of much importance is the fact that the orientation of the clay mineral flakes in the rods* is different than in the crude fullers earth. In the rods there is a marginal zone in which there is some parallel orientation of the clay mineral flakes. With high magnification, this zone can be seen to be composed of small masses of clay minerals. Each mass is composed of clay mineral flakes in uniform orientation similar to the crude earth. The orientation of each mass is slightly different from that of its neighbor, so that the effect between crossed-nicols is that of a patchwork of extremely minute masses, each with a different orientation.

"There is, therefore, an important difference in the texture of the crude and extruded earth. This can not be well demonstrated by photomicrographs† because it is evident only when the stage of the microscope is rotated. It can, however, be demonstrated to an audience by an apparatus for projecting on a screen the microscopic image as it is obtained from a thin section."

Extrusion does not accomplish any mineralogical change. The X-ray diffraction patterns for the extruded and unextruded earth are identical.

Dilute Floridin suspensions also have long been known to exhibit the phenomenon of colloidal systems called "stream-double refraction" which Hauser[14] points out is caused by parallel orientation of anisometric particles of not less than 100 Mu in length. Therefore, the recent electron photomicrographs by Humbert[15] and others of the Floridin (Attapulgite) mineral structure have confirmed to a large degree these earlier conclusions concerning its physical nature. The fibrous shape of the Floridin particle as revealed by the electron microscope may help to explain the peculiar behavior of this mineral when it is subjected to the shearing action of the extrusion process.

Extrusion undoubtedly results in an increase in the amount of active adsorbent surface exposed. This

* Extruded rods.
† Light microscope.

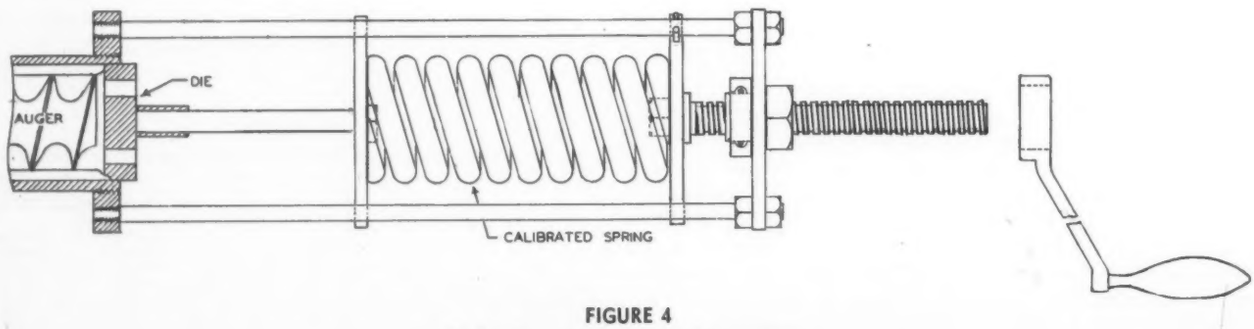


FIGURE 4
Device for measuring extrusion pressure.

TABLE 2

Effect of Extrusion On the Viscosity of Suspensions of Hydrated Floridin*

Concentration of NaCl Solution	Unextruded Viscosity, Centipoises		Extruded Viscosity, Centipoises		Percent Increase	
	Immediate	After 24 Hrs.	Immediate	After 24 Hrs.	Immediate	After 24 Hrs.
0	21.9	21.3	32.7	32.7	49	54
3	24.1	24.6	33.3	32.6	38	33
15	10.0	9.7	12.8	11.6	28	20
26.4	10.4	11.2	10.9	12.5	5	12

All suspensions contained 4 percent by weight of Floridin, dry weight basis (230° F.)
* Floridin which retains a high percentage of its natural water of hydration.

TABLE 3

Extrusion of Japanese Earth

Pressure at Die Lbs./Sq. In.	Decolorizing Capacity		Percent Free Water at Time of Extrusion
	Percent	Percent Change	
Japanese Acid Earth No. 3891			
Crude unextruded	100	....	50.1
70	87	—13	50.1
100	88	—12	50.1
135	83	—17	50.1
200	80	—20	50.1
285	72	—31	50.1
Japanese Acid Earth No. 3892			
Crude unextruded	100	....	52.1
Crude hand molded	102	+ 2	52.1
25	98	— 2	52.1
30	96	— 4	52.1
75	92	— 8	52.1
110	98	— 2	52.1
125	96	— 4	52.1
193	86	—14	52.1

Pressure increases obtained by changing dies.

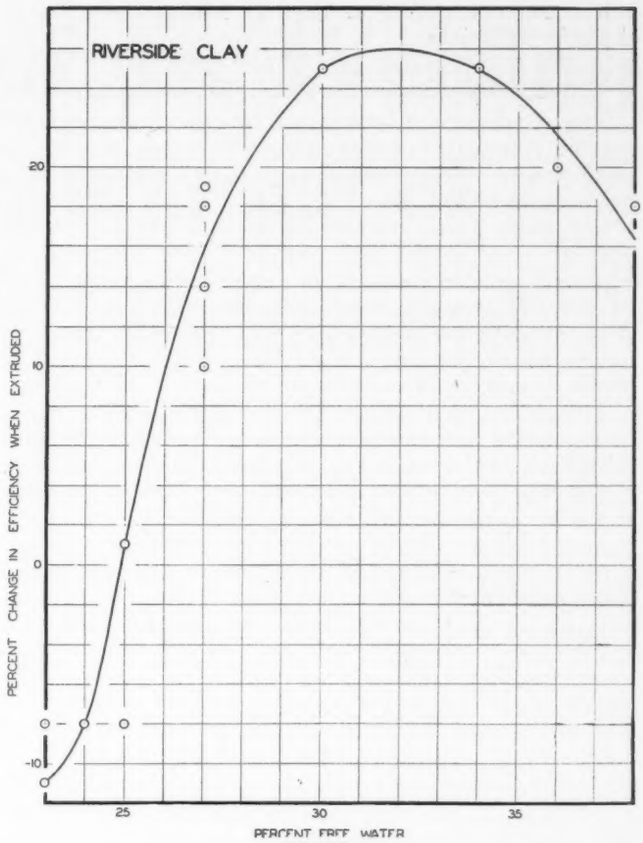


FIGURE 5

is substantiated by the data on base exchange, Table 1, and that pertaining to oil refining, Figure 2.

Furthermore, viscosity measurements on aqueous suspensions of extruded and unextruded Floridin show increases of as much as 50 percent in the viscosity.[16] See Table 2 and Figure 7.

This would indicate a smaller disintegrated particle in the extruded product. It is worthy of note that in

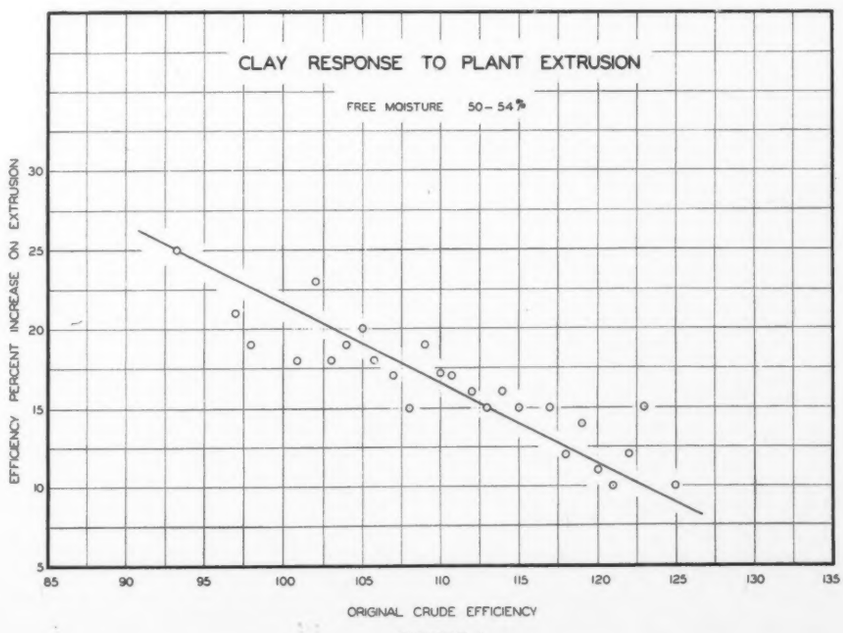


FIGURE 6

salt water containing as high as 26.4 percent NaCl, the effect persists.

Effect of Extrusion on Other Bleaching Clays

The extrusion of Olmstead fullers earth with 27 percent free water content gave a decrease in decolorizing power of 29 percent. No pressure measurements were made on this test.

Riverside Texas fullers earth was extruded with various free water contents of 23 to 38 percent, Figure 5, and an increase in decolorizing capacity of 26 percent was obtained at 32 percent free water. Also, as with other earths, negative results occur at lower water contents. Each clay has an optimum pressure and water content for the best enhancement.

The apparent density of blue English fullers earth increased 12 percent by extrusion. Because of its low initial adsorption capacity, as a percolation adsorbent, it was not possible to measure any change brought about by extrusion. It was impossible to extrude the yellow English fullers earth in the laboratory extrusion machine because of the unusual fluidity of the water-clay mixture.

Japanese acid earths, Table 3, were found to decrease in activity with increasing pressure. At pressures as low as 25 pounds per square inch, there was a decline. In one case, hand molding gave an increase of 2 percent but this is within the limit of error by the test. Only two mixtures were examined and consequently, other clay-water mixtures might be expected to give an improvement.

Summary

Floridin fullers earth, the most widely used oil decolorizing medium in the United States, has been enhanced in value about 30 percent in 10 years, largely through the addition of an extrusion step in processing. Extrusion brings about profound changes in the microscopic and possibly the submicroscopic character of the clay, which will, when thoroughly understood, throw a new light on the properties of clays.

Acknowledgment

The permission of the Floridin Company to publish this information, the helpful suggestion of K. W. Nichols, and the assistance of L. B. Christie in drawing the curves are gratefully acknowledged.

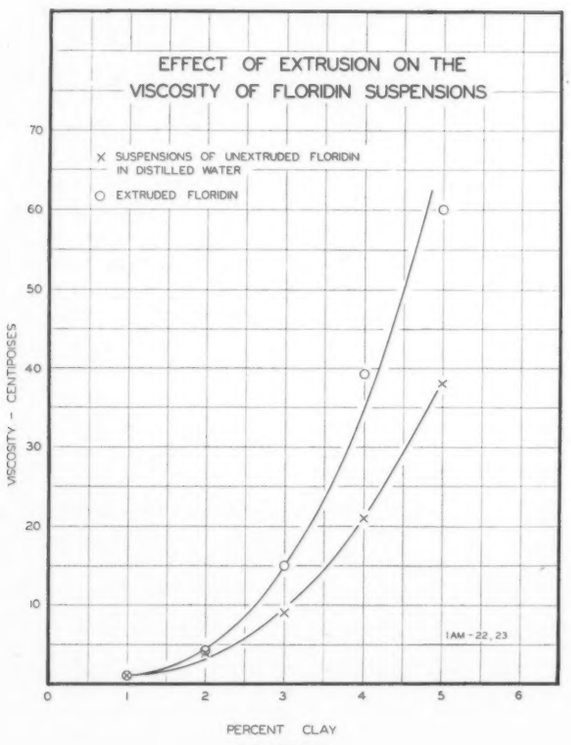


FIGURE 7

REFERENCES

[1] Cooke, C. Wythe and Massom, Stuart; "Geology of Florida," (book) 29-227, Twentieth Annual Report 1927-1928, Florida Geological Survey.

[2] Engler and Albrecht; Z. Angew. Chemie, Heft 36, 889-892 (1901).

[3] Hefter, "Technologie der Ole und Fette" (book), Vol. I, Page 661, Julius Springer, Berlin (1906).

[4] Gurwitsch, L., "Scientific Principles of Petroleum Technology", English Edition, London, Chapman and Hall (1926); J. Russ, Phys. Chem. Soc. **47**, 827 (1915).

[5] Lebedew et al, Ber. **56**, 2349 (1923); J. Russ. Phys. Chem. Soc. **60**, 441 (1928); Zhur. Obschei Khim. (U.S.S.R.) **4**, 23 (1934); **4**, 778 (1934); **5**, 48-52 (1935); **7**, 2376-2380 (1937).

[6] Kerr, P. F., American Mineralogist, **17**, 192-198 (1932); **22**, 534-550 (1937).

[7] Nutting, P. G., J. Fr. Inst., **224**, 339-62 (1937); U. S. Geological Survey, Circular No. 3 (1933).

[8] J. de Lapparent, Compt. Rend. Acad. Scie., **CCI**, 481-483 (1935); **CCII**, 1728-31 (1936).

[9] FitzSimons, Ogden; Amero, R. C.; Capell, R. G.; National Petroleum News, Oct. 29, 1941.

[10] Nichols, K. W., Oil and Gas Journal, **34**, 38 (1935).

[11] Funsten, S. R. and King, H. L., Refiner **14**, 108 (1935); **14**, 167 (1935).

[12] Hartshorne, F. W. K., U. S. Patent No. 2,079,854 (May 11, 1937).

[13] Grim, Ralph E., Private Communication (1940).

[14] Hauser, E. A., "Colloidal Phenomena" (book), Page 181, McGraw-Hill Book Company, Inc. (1939).

[15] Humbert, R. P., The Bulletin of the American Ceramic Society, **21**, No. 11, 260-263 (1942).

[16] FitzSimons, Ogden, U. S. Patent No. 2,231,328 (February 11, 1941).

An Application of Arc-Welding In the Maintenance of Heat-Transfer Equipment

W. H. PARLETTE

ANYONE familiar with the theoretical or practical operation of heat transfer equipment is well aware of the necessity of maintaining the tube pack in the unit in proper condition, in order that the equipment may be operated at maximum efficiency.

The term "proper condition" in this instance means that the interior of the tubes be kept free of scale or sediment; that the spaces between the tubes must also be kept clean and free of accumulations; that the tubes be kept free of leaks, both in the tube itself and in the roll; that the baffles be kept tight, properly spaced and of the proper diameter to maintain the proper contact or clearance with the exchanger shell; and the exchanger shell be periodically inspected, and repaired if necessary, to safely withstand the operating conditions encountered.

The most common form of maintenance encountered in meeting the above conditions usually entails retubing or a complete rebuilding of the tube pack, depending upon the condition of the tube sheets, baffles, tierods and spacers. In any event heat-exchanger maintenance, when it becomes necessary is a comparatively expensive proposition, depending of course, upon the size of the particular exchanger and the material of which it is made.

When purchased new, the exchanger dealt with in this paper was built completely of carbon-steel tubes, tube sheets, baffles, tierods and spacers. It was placed in service on a combination high-pressure petroleum-cracking unit as a crude-oil preheater in which hot heavy gas oil served as the heating medium, the crude being on the tube side and the hot gas oil on the shell side,—i.e., the outside of the tubes. The latter, as is frequently the case, proved to have a severe corrosive action upon the tube bundle, particularly in the vicinity of the shell inlet where the hot gas oil first comes in contact with the tubes. It was therefore not many months before it was necessary to retube the entire pack because of severe leaks through the corroded tube walls.

This was done, replacing the carbon-steel tubes with tubes of 4-6 percent chrome steel, which has excellent corrosion-resistant properties when used in this particular service. At the same time, due to their

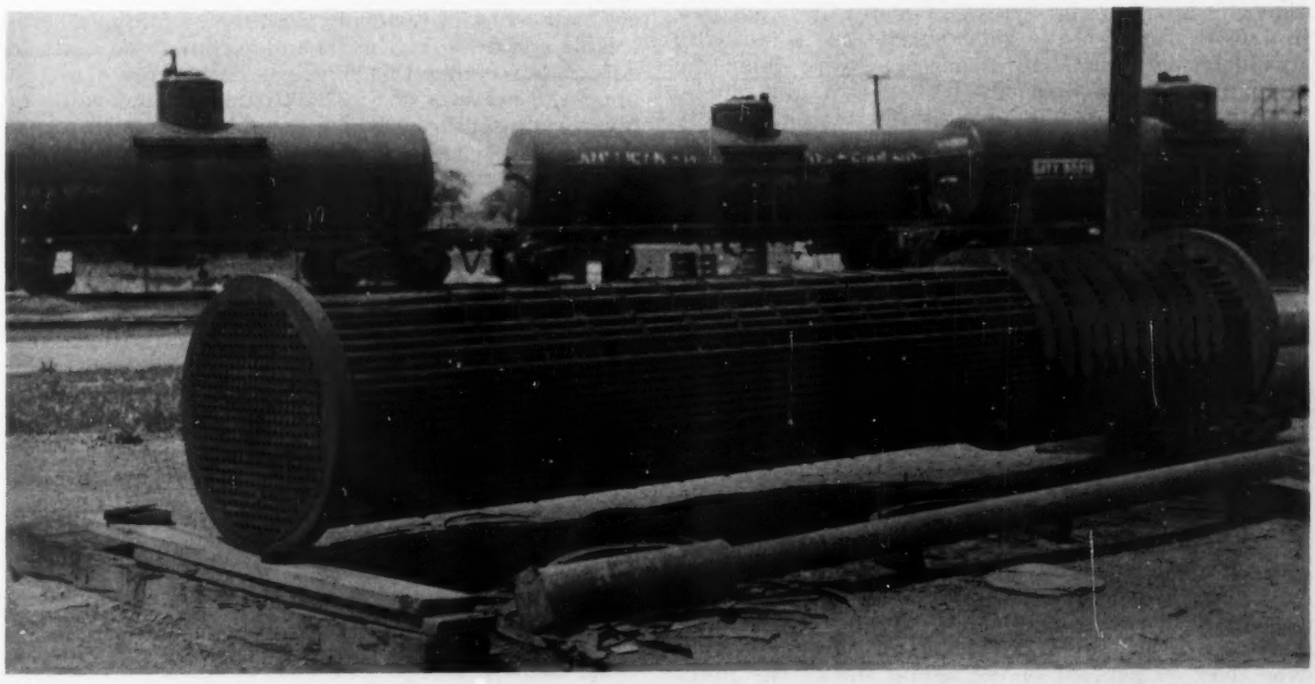


FIGURE 1

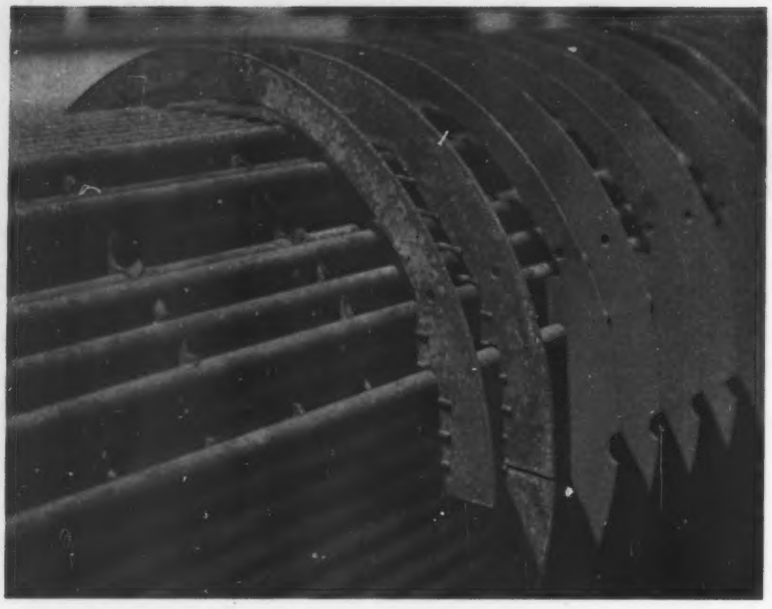


FIGURE 2

badly corroded condition, the upper ten baffles on the pack were likewise replaced with 4-6 percent-chrome baffles. Figure 1 shows these baffles. The balance of the baffles, 28 in number, were not renewed, because they were at the time in good condition. This latter proved to be an error in judgment as can be observed by inspection of the remains of these baffles at the left end of the pack. (Figures 1 and 2.) In their original condition the 28 baffles to the left of the pack were of the same shape, thickness and size as the 4-6-percent-chrome baffles at the right or top end of the bundle. However, it might be well to mention here that the shorn appearance of the left or lower end of the pack was not due entirely to corrosion, for the pictures in Figures 1 and 2 were taken after the corroded baffles had been trimmed away preparatory to beginning repair work. Nevertheless, the baffles were corroded to such an extent that the hot gas oil, instead of being directed back and forth through the tube bundle as it normally would be by sound baffles, merely swept down the comparatively clear space between the tube bundle and the exchanger shell to the outlet. This finally gave such a small transfer of heat to the crude charge to the cracking unit that a shutdown was necessary to install the spare pack which was on hand. The question then was what to do with the tube pack and with the corroded baffles, which had now become the spare.

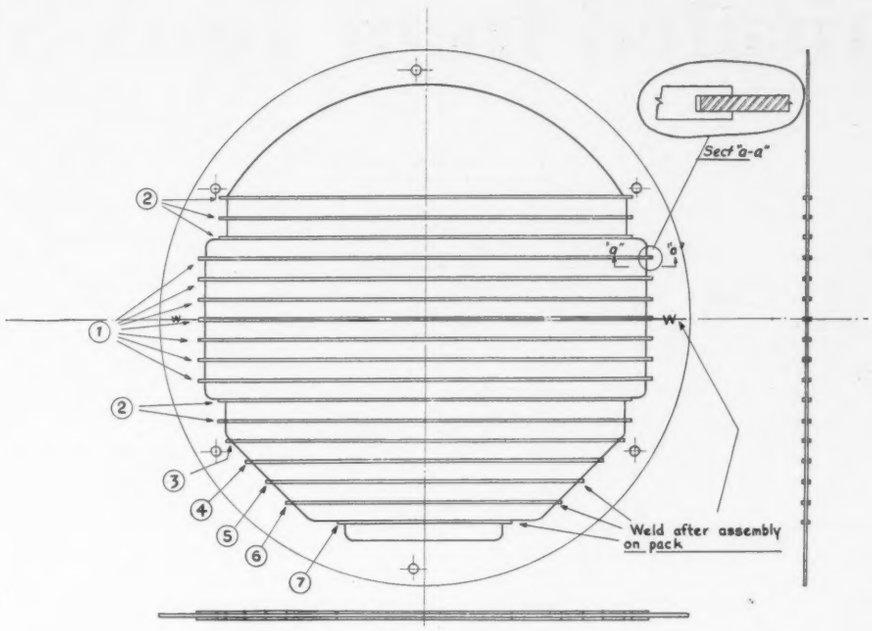
Replacement of the 28 corroded baffles would have entailed cutting down the pack and completely rebuilding with new 4-6-percent-chrome baffles and 392 new 4-6-percent-chrome tubes, each of which would cost $7.00 or a total of $2,744.00 over and above the cost of the 28 new baffles. Because of the good condition of the existing 4-6-percent-chrome tubes in the pack, it was evident that, if possible, this added expense should be avoided or at least postponed until the absolute useful life of the tubes had been realized. The new tube wall thickness in this case happened to be 12 B.W.G. which is approximately 7/64-inch. The maximum loss in wall thickness due to corrosion did not exceed 1/32-inch. It was therefore evident that well over 50 percent of the useful life of the tubes would be lost if the tube bundle were cut down completely and retubed. It would thus represent a net loss of over 50 percent ($1,372 or more) of the cost of the new tubes. In order to avoid this loss it was decided that the corroded baffles could be satisfactorily restored by welidng on partial baffles adjacent to the original baffles in the manner shown in Figure 2. It so happened that the interior portion of the original baffles were in fairly good condition because they were well protected from corrosion by reason of the accumulation which built up in the pack after the outside of the baffles had corroded away. Because of this fact, a comparatively tight baffle would result after our repairs were complete, and any leakage which would result would be of minor consequence because the hot medium would at least be directed between and around the tube surfaces.

The first step in making repairs was to thoroughly clean the tube bundle. When this was done the exposed corroded portions of the original baffles were cut away. (See Figure 2.) Next, the new partial baffles were flame cut from ¼-inch carbon-steel plate, and the 3/16-inch spacer bars were cut to length and milled on the ends to fit over the ¼-inch baffles. These parts were then assembled in the proper position on the tube bundle and welded in place as shown in Figrue 2. This figure shows one of the restored baffles completely assembled, the adjacent one-half assembled. Neither have yet been welded, but this is to be the next operation. Both halves of the partial baffle are to be welded together and the spacer bars welded securely to the baffle at both ends. Tie rods are also to be inserted through the round holes in the partial baffles. The baffles will then be securely welded to these in order that they will remain properly spaced on the pack.

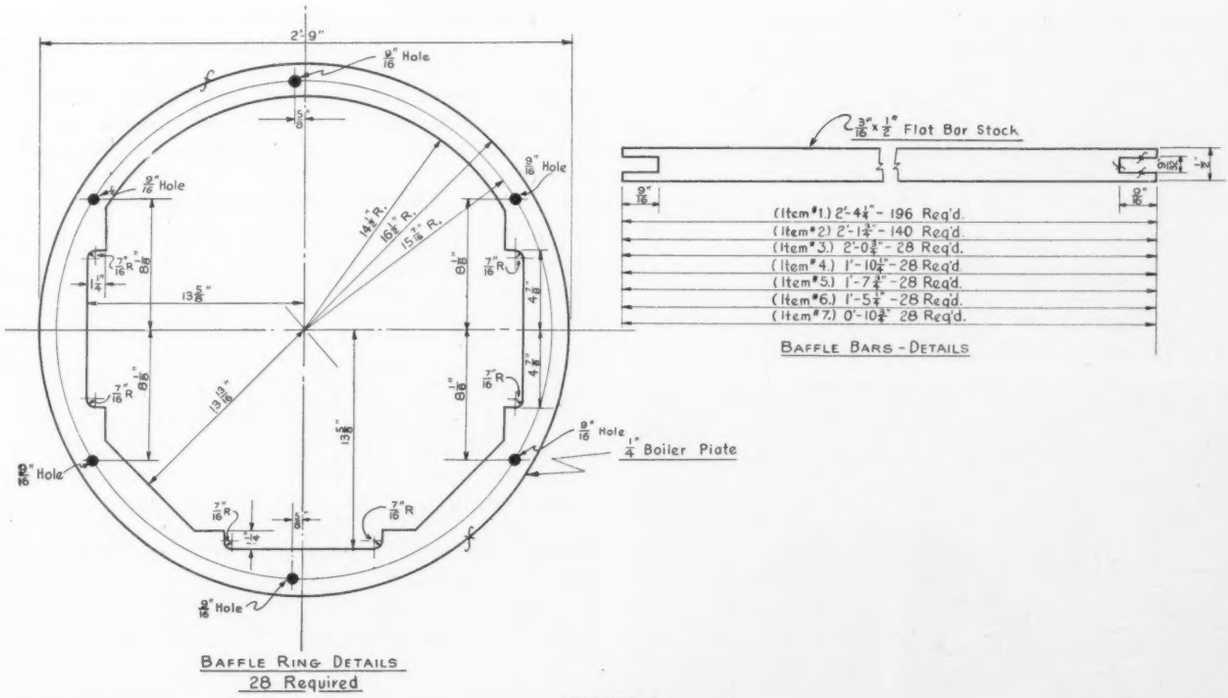
Unfortunately, at this writing, all of the work involved in restoring the tube bundle had not been completed, and for this reason no actual cost of the completed job can be presented. However, the total estimated cost of restoring the tube bundle to a serviceable condition is $360.00 and accumulated costs to date indicate that this figure is conservative. Based upon the net loss of $1,372.00 (depreciated value of the existing tubes) which would have been experienced had the pack been retubed, it is believed that a total net saving of $1,022.00 can be pointed to as a result of the repair work being performed. This figure was arrived at by subtracting the estimated cost of repair from the depreciated value of the tubes.

While it is realized that the restored pack will not be the equal of a completely rebuilt pack, it will at least give two or three years more of satisfactory service which would otherwise have been lost had not it been possible to work out a means of restoring the corroded baffles. Of course it goes without saying that this job would not have been undertaken had not facilities for arc welding been available. The cost of doing it any other way would have been prohibitive.

This manuscript and its illustrations was one of the winning studies submitted to James F. Lincoln Arc Welding Foundation. This $200,000 industrial progress award program resulted in awards going to 408 persons, who made reports of advancement and improvements in fabrication, construction and maintenance through arc welding.



BAFFLE ASSEMBLY
28 Required


2'-9"
Hole
Flat Bar Stock
Boiler Plate
(Item #1.) 2'-4¼" - 196 Req'd.
(Item #2) 2'-1½" - 140 Req'd.
(Item #3.) 2'-0⅝" - 28 Req'd.
(Item #4.) 1'-10½" - 28 Req'd.
(Item #5.) 1'-7⅞" - 28 Req'd.
(Item #6.) 1'-5¼" - 28 Req'd.
(Item #7.) 0'-10⅝" 28 Req'd.

BAFFLE BARS - DETAILS

BAFFLE RING DETAILS
28 Required

FIGURE 3

Fractionating Tower Fabricated from Tank Steel

ELTON STERRETT

WAR demands on the petroleum industry are increasing at a rate far exceeding production or development of processes. The need for such materials as toluol, for instance, has made it imperative that this fraction be isolated and utilized whenever it may be obtained from the stream of gas being processed through a natural-gasoline or recycling plant. Since such recovery is an additional step in the usual operation, additional equipment is required. This requirement postpones past probable peak demand the delivery of toluol, and by this slows down the war effort.

High-priority war needs already fill the shops and clog the floors of all manufacturers normally turning out fractionating columns and similar plant equipment. Even were they able to accept orders and be provided with the requisite new materials, fabrication would be a matter of months, and the possible reshuffling of production schedules would result only in the delay of other orders to permit expediting the desired columns.

One recycling plant, knowing that toluol could be extracted from the stream if equipment were available, investigated the normal channels for obtaining the 156-foot columns which would be required to permit extraction of the badly-needed fractions, and found that the deadline which the government wished to set for first deliveries, if the project were approved, would be doubled, and then only if more than 100 tons of new steel were made available.

In view of the steel situation and delays connected with any attempt to secure new steel for the columns, the second-hand or used material situation was canvassed, and a battery of idle 55,000-barrel storage tanks located on a site where further use of the tanks was not considered probable, in the light of either pipe-line or possible future production needs.

These tanks were purchased, and two boiler and tank manufacturing plants, neither of which had ever attempted the fabrication of any structures even approaching a fractionating column in height or design, were approached on the matter of undertaking construction. The original order was divided between the two companies, one fabricating the 9-foot diameter 156-foot tower, the other the one of the same height but with a 10-foot interior diameter.

Tank sheets, obtained by cutting each ring at the edge of the riveted lap, were then trucked to the shop, scraped to remove adhering paraffin and dirt, and then inspected for evidence of corrosion or pitting. Any serious pitting was cut out, or the sheet rejected. Localized pitting, where the minimum thickness exceeded the specified minimum of 0.375-inch, was spot-welded to fill, and the surface restored by grinding.

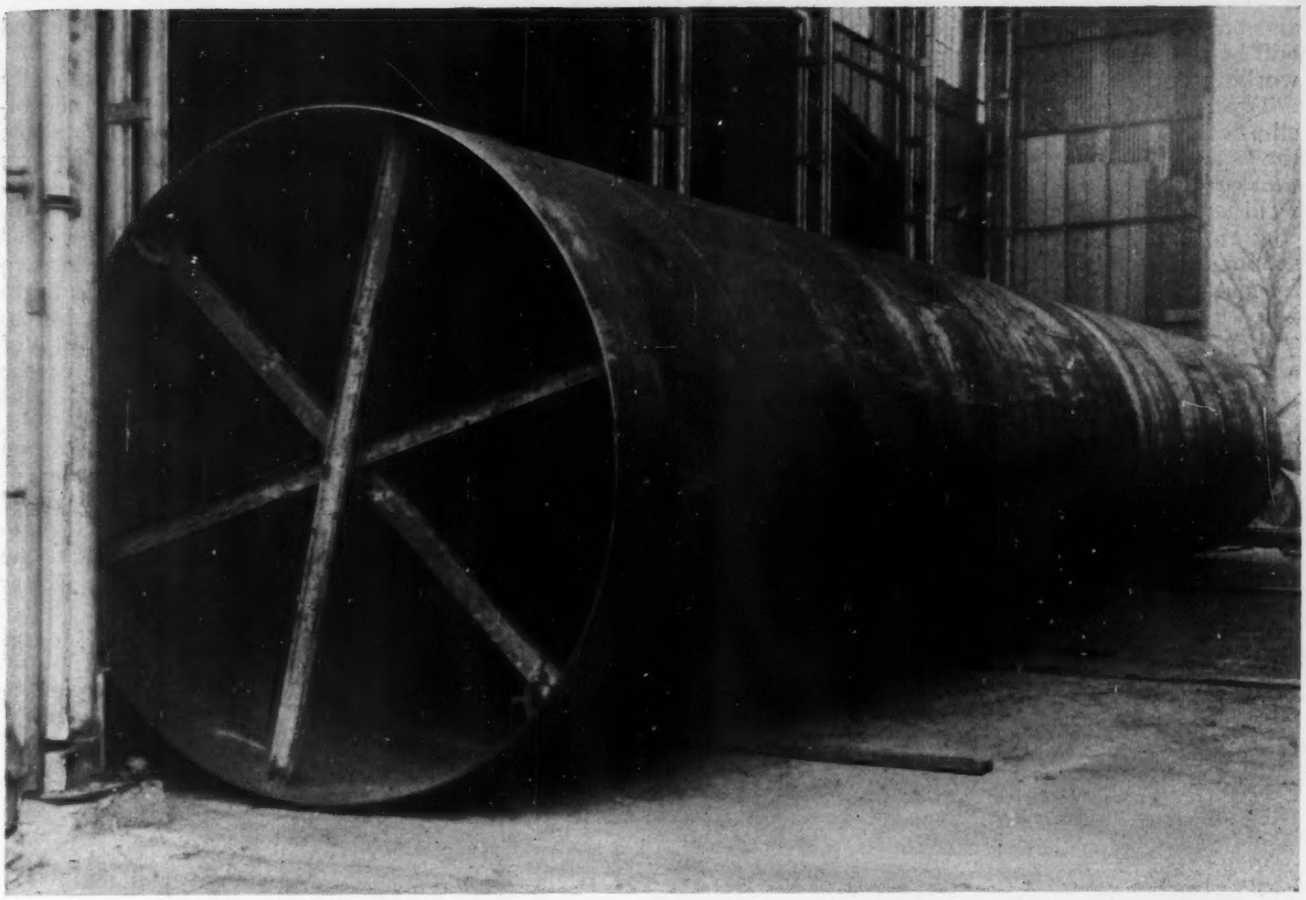
The tanks, 21 years old at the time of dismantling, were built from 17/32-inch, ½-inch and 15/32-inch steel, only the first two thicknesses being accepted for the construction of the columns. Lighter plates and tank tops were used for the fabrication of the trays and other interior equipment of the columns.

Sections Cut and Cleaned

The steel, passed by the inspector, was then beveled to provide the proper welding surface, and then given a final cleaning with wire brushes and scrapers before being passed through the bending rolls.

Bending was accomplished by the usual method, it being found very different from handling new material when passing the old steel through the rolls. The material for each ring, composed of two sheets on the 9-foot unit and two sheets plus a "dutchman" of the proper width on the 10-foot unit, was formed by welding together abutting ends of the material, completing the weld to specification as the material was placed on the shop floor. Rolling was accomplished by a pass in one direction, bringing the steel to within 3 feet of desired diameter, then passing in the oppo-

Ready for the top ring and head, this 70-foot section of one column shows the type of steel used, accuracy of welding and assembly, and method of bracing for shop fabrication. The heavy skid shoe shown just within the big tube is welded there to afford an extended anchorage for the winch line used to snake the long column from the shop floor and get it in position for tacking and welding the corresponding end section.



Portion of the 9-foot unit, with turning line attached to brace arm. The completed section is aligned on board runways, the new ring tacked on, and the entire structure revolved by winch as the welder builds up the bead tying ring to column.

site direction to complete the circle. Spot rolling was required on nearly every ring for overcoming hard spots, forming the circle adjacent to the floor weld, and to prevent the material from spiralling or twisting in the rolls.

When the ring had been formed, ears were welded a short distance on either side of the open seam, and boomers used to overcome the tension of the slight gap left in the steel. After being spot-welded, the ring was inspected for alignment, and the stringer bead then run, being followed by a filler bead and the outside of the weld completed with a third bead. Downhand welding was employed throughout, the tacked ring being rotated in the rolls to a point where the welding would be most advantageously placed. Following completion of the outside portion of the weld, a final sealer bead was run across the inside of the seam, and the ring then brought to true form by passing through the rolls with proper tension to eliminate any flat spots or inequalities.

Hammered to Relieve Stress

Since heat-treating for the relieving of any stresses within the ring was not possible, due to the absence of heat-treating equipment, an air-hammer, equipped with a blunt-nosed tool, was used to hammer the steel on either side of the weld, and thus to stress-relieve the material.

Unlike new steel, whose behavior in the rolls can be predicted, and which can be formed as a production operation, each ring for these columns was a new problem. Especially difficult to handle were sheets showing evidence of leakage at the seams. In every instance the sheets were found to have undergone a change in hardness, and to be almost spring-like in their resistance to the pressure of the rolls.

The fabrication of the columns themselves, was carried out by a modification of the stovepiping method used in pipe line practice. The newly formed ring was placed in line with the completed section of the column, tacked to it at four points, and then the completed section rotated slowly so as to allow the welder to complete the entire seam while working downhand, from a point of support on the column itself.

To permit the rotation of the entire unit and maintain the desired accuracy of positioning, wooden strips were laid across the concrete shop floor to provide continuous leveling, and a wire line, wrapped around one end of the completed work, tied to a clamp, and actuated by a hand-power winch, used to roll the entire job slowly across the floor as the welding progressed.

Coupons were cut at random from each tank plate as it was dismantled, and subjected to the usual laboratory test to determine the tensile strength of the material. All material showing below the specified minimum of 55,000 pounds per square inch was rejected, the average of the sheets used being around 58,000 pounds.

The columns are being built in two sections, due to the difficulty of transporting a unit 156 feet in length over the roads in the vicinity of the plant. Each section will be complete with welded-in end, angles for the trays, nozzles, manholes and all other fittings before being shipped, there remaining for the recycling plant only the job of making the final joining weld and erecting the completed column. Trays

and bubble caps, the trays being formed sectionally, will be passed through the manholes and arranged in working position after erection of the columns.

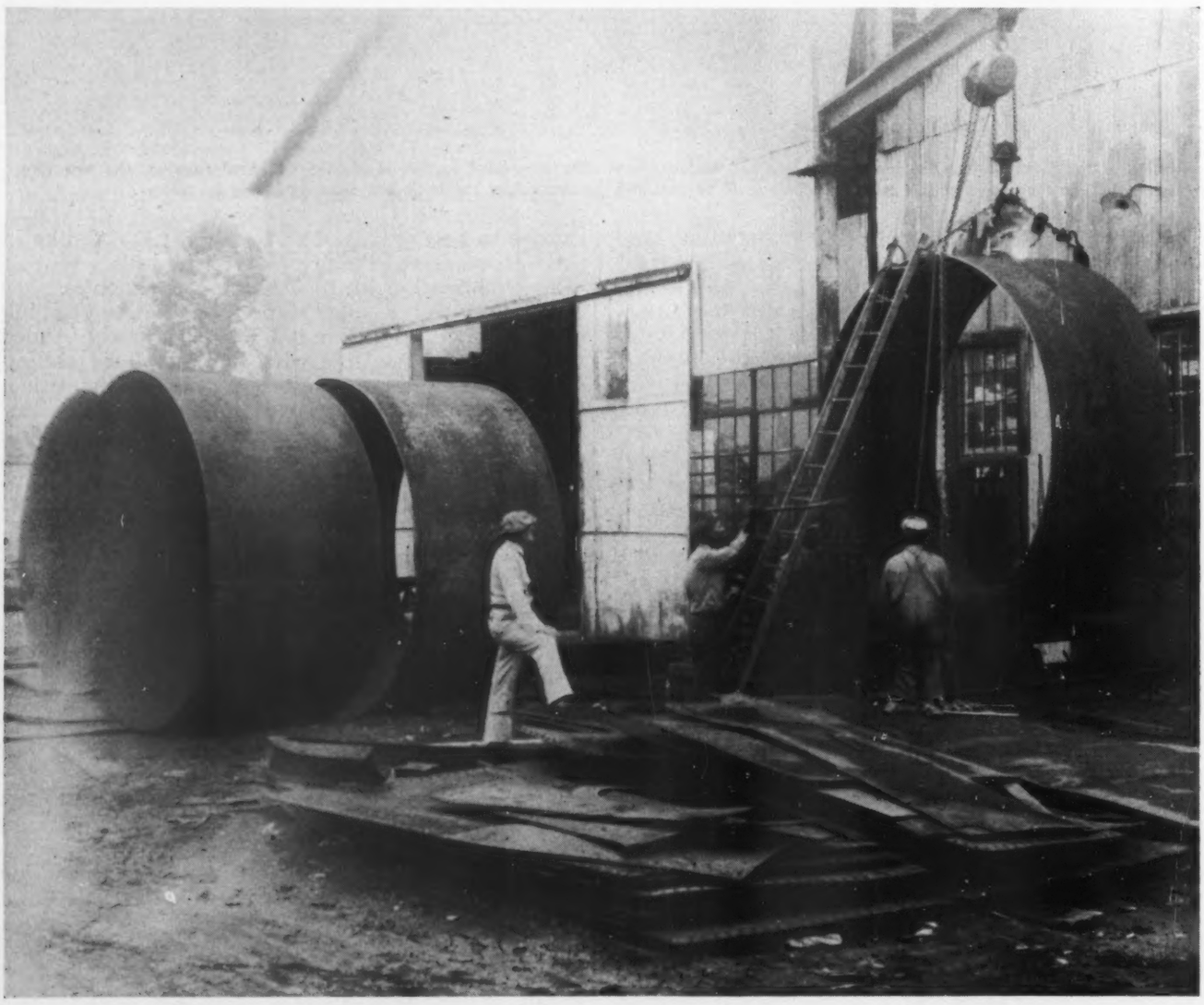
Top and bottom heads are shaped, being standard elliptical and hemispherical heads, respectively, for the 9- and 10-foot columns. The heads are welded to the top sections with the same type of single-vee weld used between rings. The bottom section of the column, or skirt, is set over the crown of the end section, and the weld made between the curve of the formed piece and the ring of the skirt. The weld, when completed, fills the space between curved head and the outer line of the skirt, extended, showing as a continuous section when buffed and painted.

The two columns are designed as self-supporting, and will be carried on 2-inch base plates. Since plates of that thickness are unobtainable, the base ring is being built up of four ½-inch plates, salvaged likewise from the 21-year-old tanks, and passed through the bending rolls to remove any camber or unevenness of surface before being built up to give the required overall dimension. Joints are staggered around the circumference of the base plate, and after assembly holes are burned through the four stacked sheets and plug welds built up to the full thickness, to tie the laminated unit together firmly. Since the base is in compression only, and the liquid pressure is held within the curved end section, the laminated structure will suffice for the column support.

Ten 3-inch foundation bolts, placed within equally spaced hold-down lugs around the skirt of the column, will tie structure to the concrete foundation. This is made wide enough to serve as supporting arm against maximum wind pressures, and heavy enough to insure stability under operating conditions.

Designed for a maximum working pressure of 60 pounds per square inch, and for temperatures not to exceed 450° F., the two columns are being built to API-ASME specifications, but will not be able to qualify for the stamp, due to the impossibility of securing heat numbers and detailed analyses of the sheets used. After the lapse of at least 21 years since erection of the tanks, no records on sheet origin, much less on steel analysis, are available. Inspection of both units is under the direct supervision of Loyd Welch.

The columns are braced at intervals with transverse members bolted to lugs welded within the circle of the various rings, and with a common center bolt to equalize transfer of load as the unit is rolled. Bracing of the columns used during fabrication will be augmented and the units supported in special cradles when handled by truck from plant to erection site.



Fabricating a ring for the 10-foot diameter, 156-foot fractionating column. The ring is built up from plates salvaged from a 21-year-old oil storage tank.

Condenser tubes

and plates for war processes

Fortunately, we have a Navy that wants, and gets, the best. For its warships, the Navy favors cupro-nickel condenser tubes made by the extrusion process. For prior to any finishing operation, an extruded tube is a sound, clean, dense piece of metal with an excellent surface . . . the kind of condenser or heat exchanger tube that can help to keep your own processes free from operating tie-ups and delays.

Years before the extrusion process for making condenser tubes became general practice, Revere began using this method. And the secondary processing of Revere tubes imparts further desirable characteristics for dependable service. Revere tubes have behind them an unusually long and valuable experience in these modern manufacturing methods.

Revere tubes and sheets are produced in a range of alloys meeting every requirement of industry at war. The Revere Technical Advisory staff is always ready to help with difficult problems.

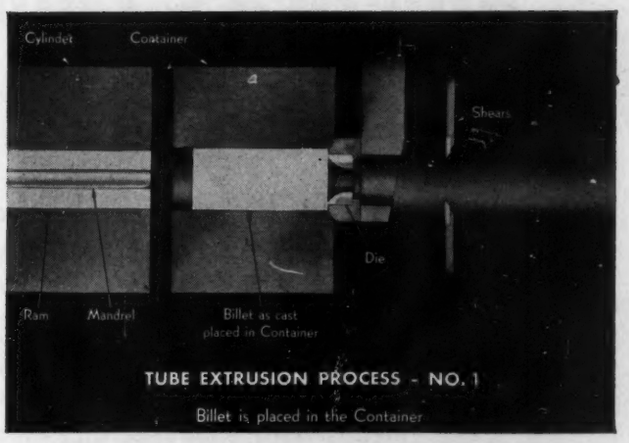
REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

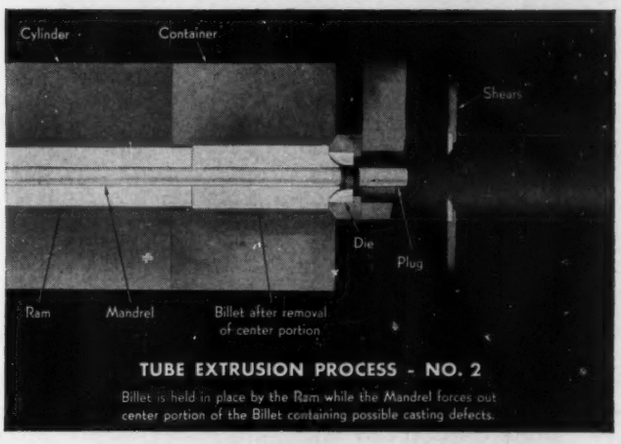
***Executive Offices:* 230 Park Avenue, New York**

Sales Offices and Distributors in Most of America's Major Cities



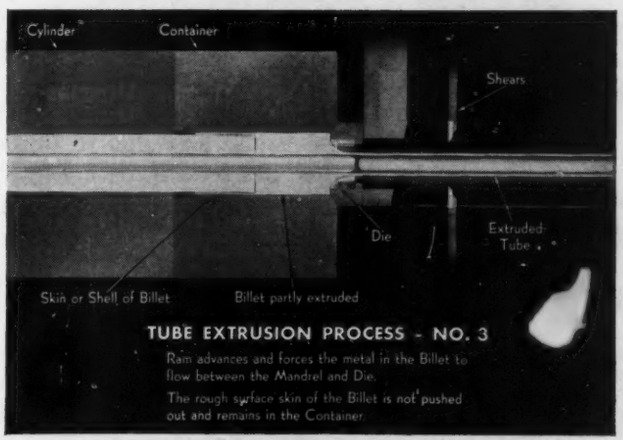
TUBE EXTRUSION PROCESS - NO. 1

Billet is placed in the Container



TUBE EXTRUSION PROCESS - NO. 2

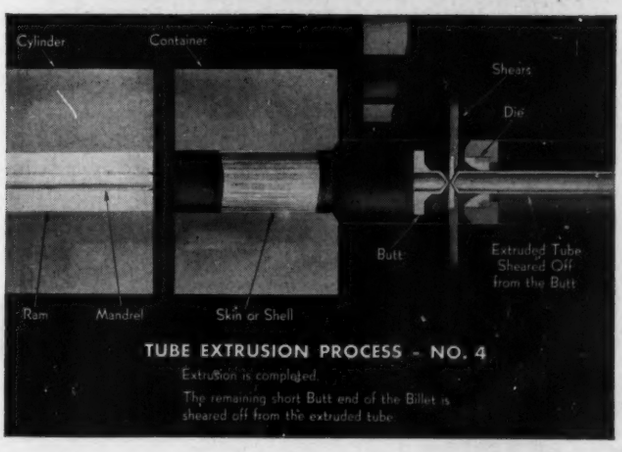
Billet is held in place by the Ram while the Mandrel forces out center portion of the Billet containing possible casting defects.



TUBE EXTRUSION PROCESS - NO. 3

Ram advances and forces the metal in the Billet to flow between the Mandrel and Die.

The rough surface skin of the Billet is not pushed out and remains in the Container.



TUBE EXTRUSION PROCESS - NO. 4

Extrusion is completed.

The remaining short Butt end of the Billet is sheared off from the extruded tube.

America's Foundation Stone

By J. Howard Pew

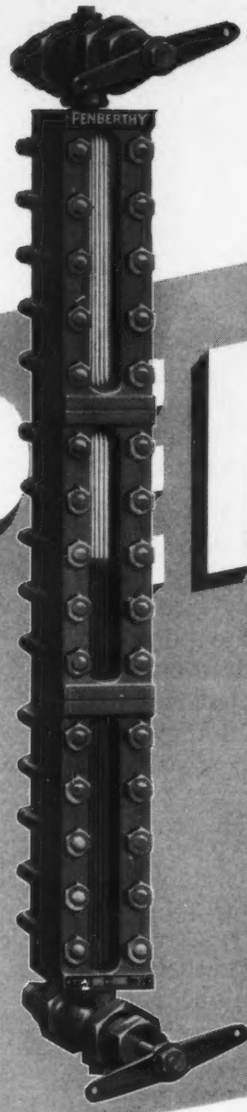
When J. Howard Pew, president of the Sun Oil Company addressed the War Congress of American Industry in New York a short time ago, he put into pungent paragraphs a thought which should appeal to every American, whether he be a member of a labor union, a representative of management, or a part of what is termed "the public" which usually means both employee and employer and those who serve or are served by employees and employers. Mr. Pew did not write this as an editorial but we feel that he will forgive us for giving his sound observations such additional circulation as lies within our power. What we reproduce below is only a part of a most interesting address but it is a part which should be reproduced as something vital to the American Way.

"SEVERAL times during the last twenty years I had occasion to make careful studies as to why our workers produce three times as much as do the workers in Europe. I thought, perhaps, we might be smarter than Europeans, but found we are not. We need only recall that our factories are largely manned by the sons and daughters of Europe. I inquired whether our natural resources were responsible for our high living standards, but found they were not. China and Russia, as well as many countries in South America and Africa, have greater natural resources than we, yet their living standards are even below those of Western Europe. I investigated to ascertain if our production achievements were in some way due to our use of machines, mass production or advertising, and found this was true in part, but that, nevertheless, these also were available to the peoples of Europe. In fact, the steam engine and the Industrial Revolution first emerged in England and spread to the European continent before reaching America.

"In short, the reason American industrial wheels turn around so much faster than those in Europe I finally found in a single word—*initiative*. American industry has it. European industry, generally speaking, lacks it. Initiative is the key to the great difference between American and European industrial production. Initiative is the psychological drive that makes the wheels of American industry go round.

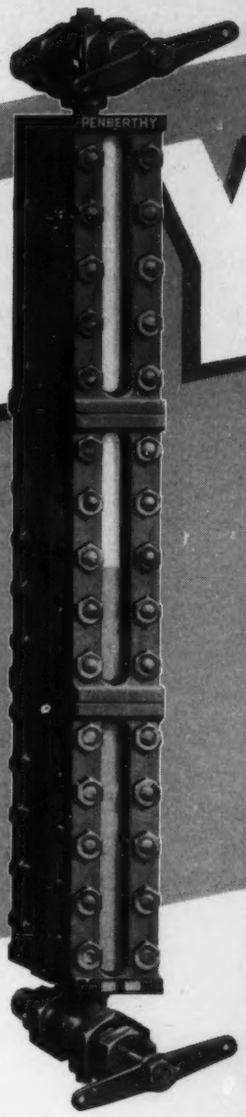
"Initiative is an intangible thing. It is not something that you can give to a man. It cannot be bought in stores; nor can it be acquired from books. Initiative is an attribute of the spirit, springing out of certain urges within mankind. A yearning for the security of one's family moves men to exert themselves beyond the requirements of mere survival. Men, too, desire recognition from their fellow men. Pride of work, pride in the superiority of their product, the doing of a better job than the other fellow, prestige of position—all these are aspirations that motivate men's actions. So, too, is the urge to improve our material well-being: to eat more or tastier food, wear better clothing, live in more comfortable homes.

"When opportunity exists for the satisfaction of these urges, men develop what we call initiative. Initiative finds its expression in competition; and competition is possible



PENBERTHY *Reflex*
DROP FORGED STEEL
LIQUID LEVEL GAGES

PENBERTHY
DROP FORGED STEEL
Transparent
LIQUID LEVEL GAGES



PENBERTHY LIQUID LEVEL GAGES *meet your requirements*

Liquid shows black—empty space shows white. Preferred wherever liquid level must be easily and positively visible . . . and when liquids are under high pressure or at high temperature.

All Penberthy Gages conform with A. P. I.—A. S. M. E. requirements.

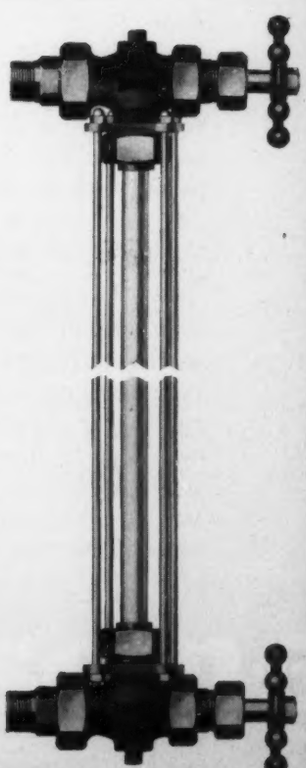
Used to observe color and density of liquids under high pressures, and/or temperatures. Construction is exceptionally rugged . . . similar to Reflex types.

PENBERTHY *Reflex*
WATER GAGE SET

Water shows black—steam shows white. U-Bolt construction is strongest and simplest to service. Glass replaced by simply removing nuts on face of gage . . . unnecessary to work between gage and boiler.

PENBERTHY
DROP FORGED STEEL
LIQUID LEVEL GAGES

Made of Chromium-molybdenum alloy temperature-resisting steel, extra heavy throughout. Stainless steel trimmed. Tubular glass type gages also available in various other metals suitable for practically all conditions.



PENBERTHY INJECTOR CO.

DETROIT, MICHIGAN • Canadian Plant; Windsor, Ontario

PENBERTHY PRODUCTS

only where there is freedom of choice and action. Where men are denied freedom of choice and action, their initiative dries up and gives way to inertia and inefficiency.

"In Europe the initiative of men has been throttled by centuries of oppression, regimentation, socialization and cartelization. By regimentation we mean the usurpation by Government of those activities which should be left to business and industry. By the European cartel system we mean conspiracies among groups of industrialists and business men to control prices and production. Neither the cartel system nor regimentation offer any reward for reducing costs or improving products. Under these systems incentive for initiative is destroyed. Freedom of decision and choice are so restricted and the opportunity for improving one's lot made so difficult, that men lose heart and give up the job. The worker, knowing that his place in life is fixed, does what he has to do to live and no more.

"Government regimentation and industrial cartels are Siamese twins of evil, for one is just as destructive of industrial production as is the other. In contrast to these limitations on initiative and originality, the American enterpriser has been largely free of all dictation save that of his individual genius and initiative. Here the door of opportunity has been kept open for every man, irrespective of creed, class or color. Here man has never been hedged in by class distinctions. The only aristocracy that counted was that based on talent and hard work. Here men found that when they succeeded they were rewarded in proportion to their achievements. Here we have had for the most part free men and free markets. This is what we mean when we speak of the American way of life. And this is why the American way of life produces three times as much goods per worker as do the European systems. . . .

"There are planners in Washington who take it for granted that we are going to win this war, and are meanwhile conspiring, under the guise of the emergency, to destroy our American way of life. I agree with these planners that America will eventually win the decision over its enemies. I completely disagree how this decision will be gained. Initiative will win the war, not regimentation. This is no time for experiments in business reform. Unfortunately the socialistic planners of the New Deal are receiving encouragement from many men whose faith in the worth of the American system is beyond challenge. Against their better judgment, they are willing to accept mild doses of regimentation on the ground that by so doing we shall be spared more drastic restrictions. These men do not know history. Power feeds on power; and the bureaucrat is never satisfied, even though he may formerly have been a business man.

"Then we have men who, while they are aware of all this, have nevertheless been led to believe that the only way to fight Hitler is to adopt Hitler's methods. This is utter nonsense. The belief that totalitarianism is synonymous with industrial efficiency, is the great myth of our age. Germany has always failed even to approach our industrial production. Of course, totalitarian countries rigidly restrict and direct their people in time of war, because their form of Government has already destroyed their initiative.

"The surest way for us to lose this war is to ape Hitler. The surest and quickest way to win this war is to place our faith in American initiative. Keep restrictive policies to the minimum of absolute necessity. Cut away the ropes of bureaucratic red tape now hamstringing industry. Give management and labor a chance to exercise initiative by reopening the door of opportunity. Do these things, and the output of war materials will soar to heights that even today would be called fantastic. Fail to do them, and we will lose initiative. Lose initiative, and we will lose production. Lose production, and we will lose the war. Lose the war, and we will lose our freedom. Lose our freedom, and we will become German or Japanese slaves."

Synthesis Plants
AMERICA PREFERS G-MV

Synthetic Rubber

•

Synthetic Ammonia

•

High-octane Gasoline

•

Toluol

•

Reforming other gases for synthetic products

To do its part in the augmented war program, Cooper-Bessemer has expanded production of the Type G-MV Compressor again and again. Noteworthy among most recent installations are two in the Gulf Coast area of 13,800 HP and 7,000 HP, respectively, and one of 24,000 in a large Midwestern plant. These G-MV's and many others are all engaged in intensive synthesis work.

Outstanding, unique design features of the G-MV which enable it to meet the severe requirement of synthesis plants are these:

1. Stamina to stand up through long operating periods between shutdowns.
2. Wide speed range for process flexibility.
3. Six stage compression, with interstage processing.

Every Cooper-Bessemer engine and compressor is backed by a field organization ready to serve you in every possible way.

by **Cooper-Bessemer**

MOUNT VERNON, OHIO AND GROVE CITY, PENNA.

Houston, Dallas, Greggton, Pampa and Odessa, Texas Tulsa Shreveport St. Louis Los Angeles Seattle, Wash.

Liquefied Petroleum Gas In 1942

G. G. OBERFELL
Vice President, Phillips Petroleum Company

IN 1942 the liquefied-petroleum-gas industry enlisted for the duration.

Normal expansion of business in the domestic field was halted by government order in January and by April all activities were brought under government supervision and restricted to war and essential civilian projects. The abrupt halt in domestic selling activity came as the first real retarding influence in an industry which had been growing at an average rate of well over 30 percent per year in good times as well as bad.

Industrial demand was severely curtailed early in the year when normal peacetime manufacturing operations were abandoned while many plants were being tooled for war production. As soon as conversions were completed the industry was called on for greatly increased deliveries. In the fourth quarter particularly, the completion of new war plants built since the attack on Pearl Harbor has increased demand for liquefied petroleum gases at a greatly accelerated pace.

G. G. OBERFELL

Increase 19 Percent

For the year as a whole it is estimated that marketed production of liquefied gases totaled 548,000,000 gallons, an increase of 19 percent over 1941. This is the smallest percentage increase in demand since 1938. In 1941 the increase was 47.7 percent, in 1940 the increase was 40.2 percent. The convenience of liquefied gas for domestic use and the many advantages of this type of fuel for manufacturing operations had been so well sold by the industry that 1942 demand undoubtedly would have exceeded 600,000,000 gallons had it not been for the restrictions made necessary by the war.

TABLE 1
Marketed Production of Liquefied Petroleum Gas Distribution
Gallons Per Year

YEAR	Gallons per Year	Percent Increase Over Previous Year	Domestic	Percent Increase Over Previous Yea.	Industrial and Miscellaneous	Percent Increase Over Previous Year	Gas Manufacturing	Percent Increase Over Previous Year
1922	222,641	....	Sale of liquefied petroleum gas confined primarily to bottled gas business prior to 1928					
1923	276,863	24.4						
1924	376,488	36.0						
1925	403,674	7.2						
1926	465,085	15.2						
1927	1,091,005	134.6						
1928	4,522,899	314.6	2,600,000	....	400,000	....	1,500,000	....
1929	9,930,964	119.6	5,900,000	126.9	1,500,000	275.0	2,500,000	66.7
1930	18,017,347	81.4	11,800,000	100.0	2,200,000	46.7	4,000,000	60.0
1931	28,769,576	59.7	15,294,648	29.6	7,171,686	226.0	6,303,242	57.6
1932	34,114,767	18.6	16,244,103	6.2	8,167,194	13.9	9,703,470	53.9
1933	39,391,008	14.1	16,625,588	2.3	13,987,095	71.3	8,318,325	—14.3
1934	56,427,000	44.9	17,681,000	6.3	32,448,000	132.0	6,298,000	—24.3
1935	76,855,000	36.2	21,380,000	20.9	47,894,000	47.6	7,581,000	20.4
1936	106,652,000	38.8	30,014,000	40.4	67,267,000	40.5	9,371,000	23.6
1937	141,400,000	32.7	40,823,000	36.0	89,402,000	32.9	11,175,000	19.3
1938	165,201,000	16.7	57,832,000	41.7	94,983,000	6.2	12,386,000	9.8
1939	223,580,000	35.3	87,530,000	51.3	120,615,000	27.0	15,435,000	24.6
1940	313,456,000	40.2	134,018,000	53.1	159,153,000	32.0	20,285,000	31.4
1941	462,852,000	46.5	220,722,000	65.0	216,875,000	35.8	25,255,000	24.4
1942	555,000,000	20.1	265,000,000	20.0	262,400,000	21.0	27,600,000	9.3

It is estimated that 125,000 new domestic consumers of liquefied petroleum gases were added in 1942 despite the cessation of selling activity. A greater part of these were added early in the year before the industry was restricted. In 1941 there was an increase of 520,000 users. Some new installations have been made throughout the year at war housing projects. Total number of domestic consumers at the end of the year is estimated at 1,825,000.

Table 1 gives details of liquefied petroleum gas demand by major types of use in 1942 compared with previous years. This tabulation does not show the volume of liquefied gases used in the production of aviation gasoline or synthetic rubber. Consumption at chemical plants, served by pipe line with hydrocarbons in a gaseous state, has not been included. An effort has been made to eliminate duplications where products have been resold to others.

Use by Refineries

Utilization of liquefied gas fractions at oil refineries for the production of aviation gasoline has increased rapidly during the past year. If these fractions were included in this report the total consumption of liquefied gases would have shown an even greater increase than in recent years. An increasing volume of normal butane is moving to isomerization plants. Isobutane is being segregated wherever possible for alkylation with unsaturates to produce 100-octane aviation gasoline.

Propane supplies at refineries have been affected by the segregation of propylene for cumene manufacture. At many plants isomers and unsaturates are being removed from ordinary motor fuel and the volatility is being restored by the use of normal butane. Some propane has been blended with motor gasoline to increase volatility in emergencies when butane supplies were low.

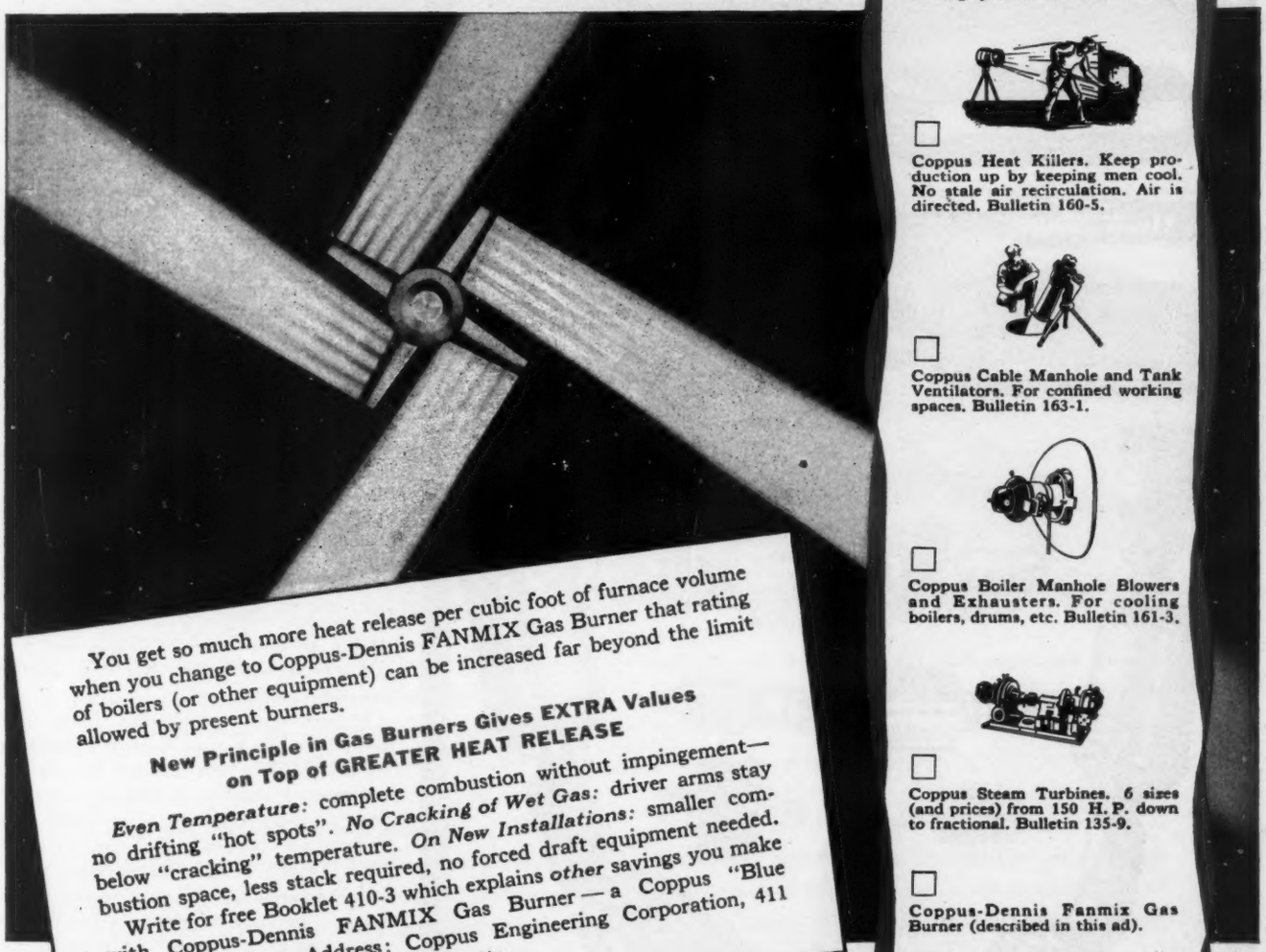
As the national synthetic-rubber program which is based on the utilization of C_4 cuts gets into full swing in 1943, the liquefied-petroleum-gas industry is expected to continue its recent trend of placing more emphasis on propane. In

HOW TO INCREASE THRU-PUT BY ONE SIMPLE CHANGE

Pinwheel Action STEPS UP RATINGS

Installing Coppus-Dennis FANMIX Gas Burners permits increased heat release per cubic foot of furnace volume

"Pinwheel Action" combines gas with air in a properly proportioned mixture. Gas escaping from orifices in the blades, rotates the fan, causing in-take of air at right angles to path of gas. The energy in gas under pressure is utilized to perform work by mechanically mixing and proportioning the gas with just the proper amount of air, thus eliminating from the furnace the necessity of serving as a mixing chamber as well as combustion space.



You get so much more heat release per cubic foot of furnace volume when you change to Coppus-Dennis FANMIX Gas Burner that rating of boilers (or other equipment) can be increased far beyond the limit allowed by present burners.

New Principle in Gas Burners Gives EXTRA Values on Top of GREATER HEAT RELEASE

Even Temperature: complete combustion without impingement—no drifting "hot spots". *No Cracking of Wet Gas:* driver arms stay below "cracking" temperature. *On New Installations:* smaller combustion space, less stack required, no forced draft equipment needed. Write for free Booklet 410-3 which explains *other* savings you make with Coppus-Dennis FANMIX Gas Burner — a Coppus "Blue Ribbon" Product. Address: Coppus Engineering Corporation, 411 Park Avenue, Worcester, Massachusetts.

You'll get valuable ideas from these free bulletins on other Coppus Blue Ribbon Products

(Check the ones you want)

☐ Coppus Unit Air Filters. For industrial ventilating and air conditioning systems. Bulletin F-320-5.

☐ Coppus Heat Killers. Keep production up by keeping men cool. No stale air recirculation. Air is directed. Bulletin 160-5.

☐ Coppus Cable Manhole and Tank Ventilators. For confined working spaces. Bulletin 163-1.

☐ Coppus Boiler Manhole Blowers and Exhausters. For cooling boilers, drums, etc. Bulletin 161-3.

☐ Coppus Steam Turbines. 6 sizes (and prices) from 150 H. P. down to fractional. Bulletin 135-9.

☐ Coppus-Dennis Fanmix Gas Burner (described in this ad).

Name.....

Company.....

Address.....

City..... State.....

COPPUS

Sales Offices in THOMAS' REGISTER. Other "Blue Ribbon" Products in REFINERY CATALOG.

COPPUS BLUE RIBBON PRODUCTS DESIGNED FOR YOUR INDUSTRY . . . ENGINEERED FOR YOU

1942 propane consumption for normal liquefied gas uses increased much more rapidly than butane.

In Lubricants

Oil refiners are using greater quantities of propane in lubricating-oil manufacture. Recently, it was stated that propane now is used to improve the quality of more than half of all lubricating oils produced. Volume used for this particular purpose is relatively small when compared with total propane production but in the aggregate such small uses have an important effect on total demand.

Shortages of other fuels have had a substantial effect on the demand for liquefied gases in 1942. The great increase in the demand for acetylene has created a shortage of that gas with the result that the use of propane for metal cutting has increased to a remarkable extent. More shipyards and other fabricators of steel sheets and plates have been using propane for cutting and saving acetylene exclusively for welding.

The manufacture of small-caliber ammunition, shell cases and bombs ranging in size from the 250-pound variety to the recently developed "block busters" has taken an increasing volume of liquefied gases in 1942. In the manufacture of small-caliber ammunition the fuel is used primarily for annealing of non-ferrous metals. A separate annealing operation at 1100 to 1350° F. is required after each of a series of operations in forming the cases. The noncorrosive features of sulfur-free liquefied petroleum gases make them valuable in non-ferrous metal processing.

Work done on large shells is similar to that required on forgings. The bare stock is heated to 2000° F. or higher before going to the presses. Manufacture of bombs depends on the size and type but in all cases carefully controlled heating operations are required and manufacturers have found that liquefied petroleum gases are highly desirable as fuel due to purity and ease of accurate control.

Butane-propane mixtures are being used in mining machinery in the greatly enlarged operations of the nation's iron mines. Mine operators have been employing Hessleman engines as prime movers on new machines. At one mine employing such engines remarkable service records have been achieved. Trucks hauling 15 tons of ore per trip up 8 percent grades have operated 9000 hours without stops for maintenance. It was necessary to change lubricating oil only once every 1000 hours on these units. An overall increase in efficiency of 20 percent has been achieved after conversion to liquefied gas fuels.

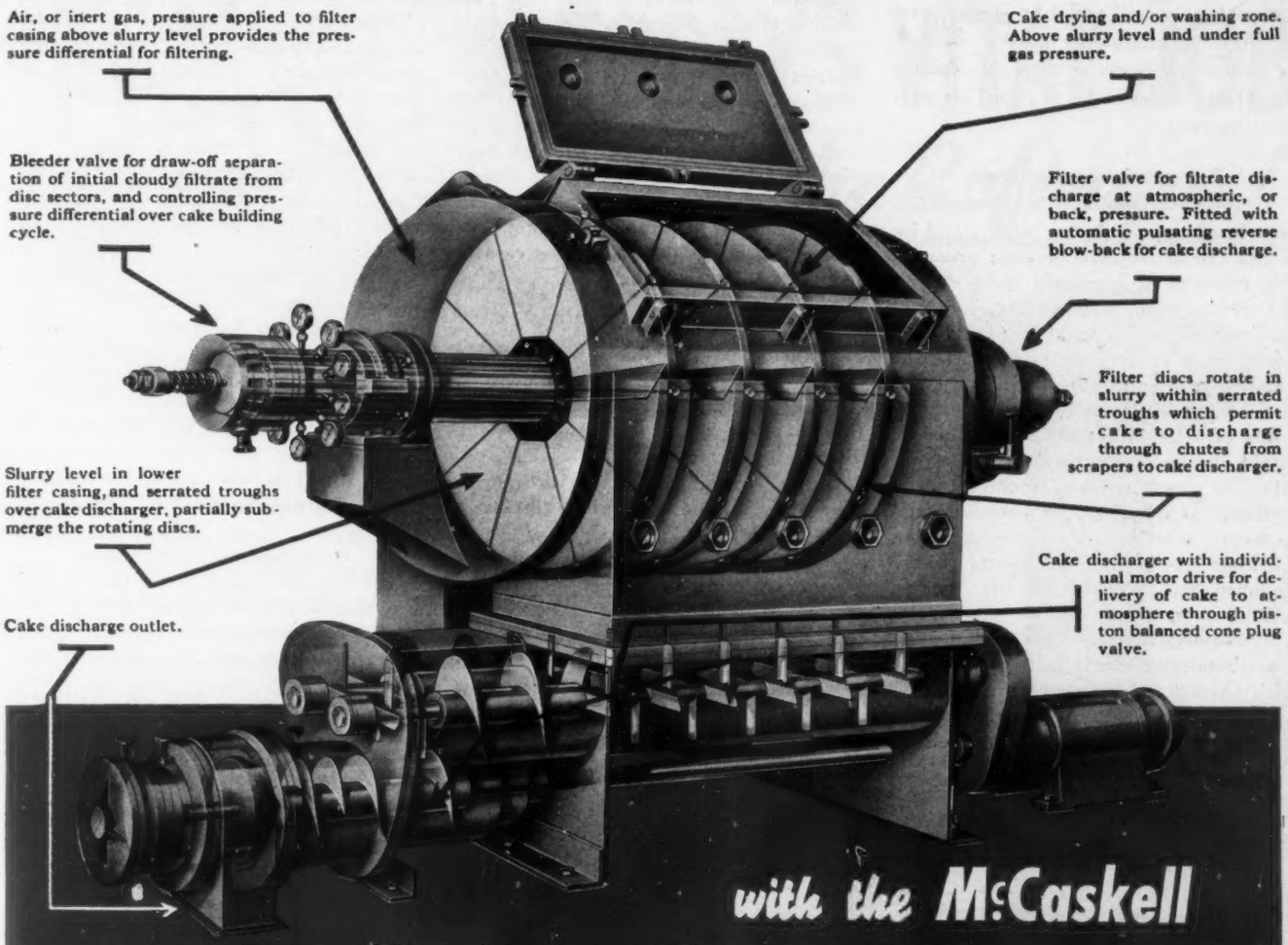
Army Large User

Army camps are large users of both propane and butane for cooking and water heating. One California camp not adjacent to natural gas service uses 20,000 gallons daily of liquefied gases. Hospital sterilizers designed originally for gas are using liquefied gas when installed at army camps. Small war vessels of the corvette tpye use bottled gas for cooking.

Experimental work has been conducted in the use of liquefied gases to replace high-octane motor fuel in the testing and running-in of high-compression aviation engines. The work was undertaken because the use of such gases would release substantial quantities of high-octane gasoline for actual flying operations, particularly in the pilot-training program. Work also has been done in the experimental use of such gases for cold-weather starting of airplane engines and partial use during the warming-up period. Since butane has an octane rating of about 90- and a propane rating of over 100-octane the fuels meet the most important characteristics required of an aviation fuel. Flight use is, of course, not being considered due to the container weight.

Prospective shortages of natural gas during peak-load periods in certain

Now . . . CONTINUOUS PRESSURE FILTRATION


Air, or inert gas, pressure applied to filter casing above slurry level provides the pressure differential for filtering.
Cake drying and/or washing zone. Above slurry level and under full gas pressure.
Bleeder valve for draw-off separation of initial cloudy filtrate from disc sectors, and controlling pressure differential over cake building cycle.
Filter valve for filtrate discharge at atmospheric, or back, pressure. Fitted with automatic pulsating reverse blow-back for cake discharge.
Filter discs rotate in slurry within serrated troughs which permit cake to discharge through chutes from scrapers to cake discharger.
Slurry level in lower filter casing, and serrated troughs over cake discharger, partially submerge the rotating discs.
Cake discharger with individual motor drive for delivery of cake to atmosphere through piston balanced cone plug valve.
Cake discharge outlet.

with the McCaskell Rotary Disc Continuous Pressure Filter (PATENTED)

The McCaskell Rotary Disc Continuous Pressure Filter makes available now—for the first time—continuous pressure filtration with continuous automatic discharge of the dry cake to atmosphere. Pressure filtration readily handles volatile solvents and viscous and high temperature slurries. Higher differential pressures (to 100 pounds gauge pressure operation in standard construction units) provide high and uniform filter rates and lower moisture content filter cakes. Continuous automatic pressure filtration permits of continuous processing, with important economies in space, labor and maintenance not afforded by batch pressure filtration methods. Indicated for the replacement of batch pressure filters in petroleum refineries for the removal of contacting clays from residual and overhead lube stocks.

Standard sizes range from 25 to 800 square feet of filter area. Fabricated in all the usual metals and from a wide range of the special metals and materials for corrosion resistance. Our experienced filtration engineers and facilities are at your disposal.

Manufacturers of GB **FILTERS and EVAPORATORS**

GOSLIN-BIRMINGHAM MFG. COMPANY

CHICAGO
NEW ORLEANS
TULSA

BIRMINGHAM, ALABAMA
350 Madison Ave., New York City

SALT LAKE CITY
SEATTLE
SAN FRANCISCO

areas has created a large demand for stand-by installations since the declaration of war. Government agencies have urged some manufacturers of critical materials to install stand-by storage and gas diluting equipment so that in case of natural or manufactured gas failure the plants will not be required to suspend operations.

Transportation Problems

From the standpoint of the liquefied petroleum gas industry the stand-by plants are a problem because prospective refills of storage will come during the winter months when the domestic heating load and normal industrial consumption is at its peak, particularly for butane-propane mixtures. Initial loads can be supplied readily but a sudden influx of a large number of refill orders might prove embarrassing. Likewise, stand-by installations require large amounts of hard-to-obtain-steel-storage capacity which could otherwise be working every day in plants where liquefied gas is used as the regular fuel.

Transportation has been perhaps the most important single factor interfering with smooth operation of the industry during the past year. The lack of tankers for transportation of crude oil to the East Coast which created the gasoline and fuel-oil shortage likewise affected the Eastern supply of liquefied petroleum gases. Normally most of the liquefied gas consumed on the Atlantic Seaboard is produced at East Coast oil refineries as a by-product of gasoline cracking processes. When Eastern refineries were compelled to reduce runs of crude oil the liquefied gas distributors were forced to haul products from western producing points. If tank cars were plentiful this would not be a serious matter as long as the railroads are functioning as efficiently as they are today. But there are no surplus cars in the high-pressure fleet.

Fewer Rail Cars

From the standpoint of available transportation capacity, the industry's fleet actually decreased during the year. This is because of long hauls to the East and the large number of cars being used constantly for the transportation of isobutane and other alkylation and blending feed stock from gasoline plants to oil refineries. Toward the end of the year, the volume of material to be moved in pressure cars increased as the 100-octane and synthetic-rubber projects got under way.

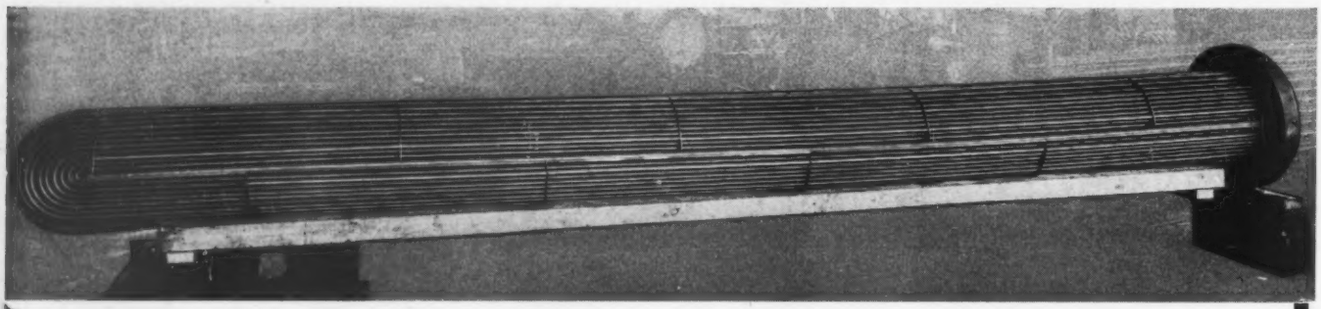
Taking note of the critical winter transportation situation, the government recently advised all users of liquefied gases to keep their storage tanks full. Liquefied gas distributors have been preaching the same gospel for some years.

Truck transportation has been effective in avoiding a crisis in liquefied gas transportation. The Office of Defense Transportation issued an order in June requiring that all distributors use trucks for the delivery of liquefied gases within a radius of 100 miles of the producing point. Later this trucking radius was extended to 200 miles. Only by obtaining special permission is it possible to use tank cars for hauls of less than 200 miles.

While it has not been possible to avoid asking for special permits on some shipments, the industry has made great progress in this direction. One distributor has been able to eliminate 1300 tank-car trips by the use of trucks. Assuming that a tank car will make 30 trips per year, this one distributor, in effect, added 40 tank cars to the nation's fleet by increased use of tank trucks.

Governmental Regulation

The liquefied gas industry has burned a good deal of midnight oil during 1942 in the preparation of reports required by various government agencies. It has required a great deal of time and effort to comply with all of the government directives made necessary by the war. The industry got its first taste of opera-



WHITLOCK STANDARD U-TUBE CONSTRUCTION

for Heat Exchangers and Extraction Feed Water Heaters Has Practical War-Time Value — Saves Material, Machining, and Assembly Time!

For years Whitlock Heat Exchangers, Feed Water, Fuel Oil, Instantaneous, and Service Water Heaters have featured U-Tube heating sections (though all types specified by customers have been and are made).

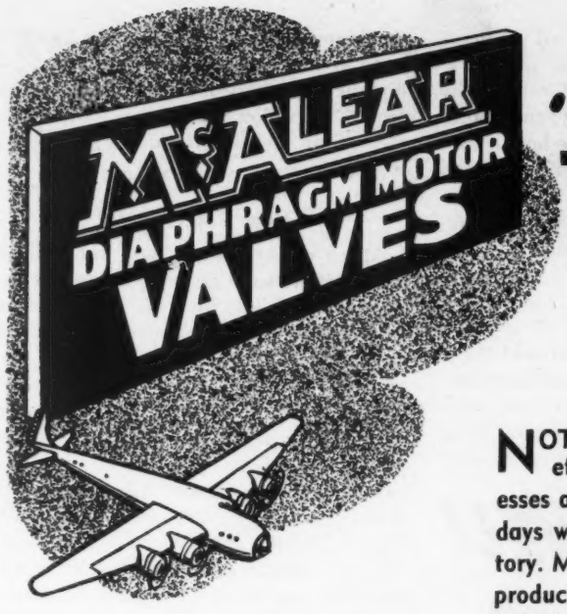
The U-Tube section has the obvious advantage of expanding and contracting independent of the shell. Its resulting advantages, always important, are even more practical in war time. Materials used in alternate constructions are saved—such as floating tube sheet, floating head and rear head of shell. Valuable time used in machining these parts and in assembly is saved as making U-bends and welding shell ends takes substantially less time.

All this helps to get vital war units at work quicker; the one aim of the whole Whitlock organization. Can we help you? Write fully.

THE WHITLOCK MANUFACTURING CO.

76 South St., Elmwood Hartford, Conn.

District offices in New York, Boston, Chicago, Philadelphia, Detroit, Richmond

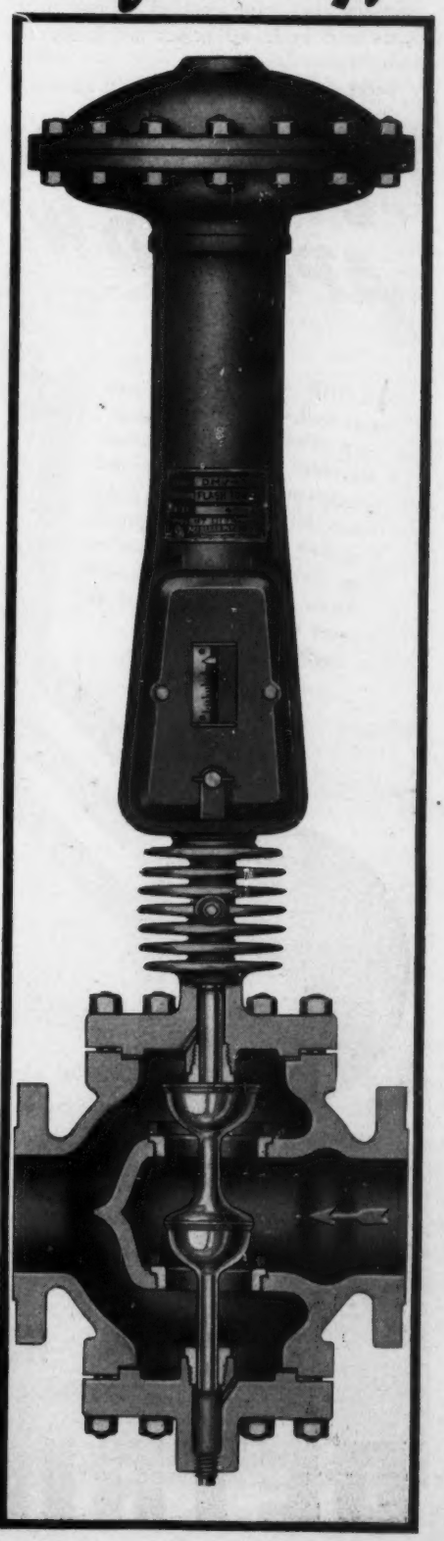


.....Qualified for TODAY'S VITAL JOB in the Refinery!

NOTHING short of maximum efficiency in refinery processes and practices will do these days when oil is so vital to Victory. Making refinery equipment produce more fighting fuels is today's challenge. But refiners are meeting this challenge successfully . . . and McAlear Diaphragm Motor Valves are helping them. In fact, these valves are taking in stride the important job of increasing refinery output. It is precisely the job they have been performing for years. They have consistently provided extremely accurate control of rates of flow, pressures and liquid levels. They have contributed to increased output in other ways as well—in holding downtime to an absolute minimum, in ease of maintenance, in greater dependability and economy, in soundness of engineering that gears them to wartime production schedules.

Yes, McAlear Diaphragm Motor Valves are qualified to help refiners in the tremendous job they are doing today—and equally important, these valves are engineered and built to fit into the refiners' post-war plans.

Specify McAlear Diaphragm Motor Valves for your refinery. Your request for complete details will be given immediate attention.



SMOOTH PERFORMANCE

Ball bearings at several points in superstructure . . . multiple springs and large diaphragms . . . top and bottom stem guides . . . these McAlear construction refinements mean smoother performance.

FULL CAPACITY FLOW

Full pipe size capacity is assured by high lift inner valve and full body opening. Streamlined interior design reduces turbulence, produces continuously smooth flow through these valves.

EASE OF MAINTENANCE

Shouldered, removable seat rings! Both rings readily accessible and are inserted in body from same direction. Saves time and labor, minimizes downtime.

MORE FLEXIBILITY

Essential flow characteristics for operation with either pilot or instrument type controls embodied in these valves. Also quickly changed—ON THE JOB—from direct-seated to reverse-seated valves merely by reversing body and plug.

GREATER RIGIDITY

Top flange and stuffing box cast integral; top and bottom flanges of semi-steel and cast steel valve bodies securely held with milled studs—not machine bolts. Assurance of vibrationless installations!

FULLY ENCLOSED

Working parts safeguarded against damage by completely enclosed superstructure. Tampering with adjustments also prevented. Valve indicator plainly shows exact position of valve at a glance.

THE McALEAR MFG. CO.

1901-7 S. WESTERN AVENUE CHICAGO

SALES ENGINEERS IN PRINCIPAL CITIES

tion under war-time conditions on January 14 when the War Production Board issued M-68-c directing the industry not to make any new liquefied petroleum gas installations. In April this was followed by L-86 freezing all stocks of equipment and stopping all domestic sales activity except under special permit.

Although many elements of liquefied gas cost have risen, the industry's prices have been frozen under OPA 88.

Office of Defense Transportation directives also have created special problems and built up paper work for the industry.

In the domestic distribution activities of the industry a number of changes have been made in methods of operation to conserve rubber and relieve the manpower shortage. Some companies selling on a meter basis have begun billing customers every two months instead of every month. With no merchandising activity it has been possible to divert manpower from selling to other work.

Total supply of liquefied gases has increased during the year at gasoline and recycle plants built primarily to produce isomers for aviation gasoline. Oil refineries also have increased their output of some liquefied gases as a by-product of the manufacture of unsaturates and isomers for aviation gasoline and synthetic rubber. Production of liquefied gases at oil refineries increased from 10 million gallons in January to more than 20 million gallons per month in midsummer.

New Plants Built

Much of the new production at natural gasoline and recycle plants became available so late in the year that its effects will not be noted until next year. In Illinois, for example, two plants with a total daily production of 100,000 gallons of liquefied gases were brought on stream in the final quarter of the year. One did not start until late in December. Another Illinois plant is being remodeled to produce an additional 50,000 gallons daily beginning about January 1. Illinois production of liquefied gases in 1943 may be nearly 50,000,000 gallons greater than in 1942.

Louisiana and Texas also have increased production through completion of new plants in 1942. A number of other plants will be ready for operation in the early part of 1943. In all instances new plants now being completed are equipped for the fractionation of isobutane and other special cuts needed for aviation gasoline and rubber. Construction of new plants is not permitted unless special war commodities are produced.

The effective supply of liquefied gases has been increased in a number of instances by changes in transportation facilities. A large chemical plant in Texas formerly was supplied with propane by tank car. Now it obtains its hydrocarbon raw materials in gaseous form by pipe line from a gasoline plant. This released former supplies and tank cars for other consumers.

Having devoted itself wholeheartedly to war production, the liquefied petroleum gas industry can take great satisfaction from its record of service to the country in the first year of the war and look forward to a busy year in 1943. Problems of manpower, maintenance of equipment and transportation will insure the industry against any tendency toward boredom in the year just opening.

Control Removed on Aviation Gasoline

All price controls on aviation gasoline of 87 octane and higher ratings were eliminated by the Office of Price Administration December 29.

The action was taken on the recommendation of PAW approved by the Defense Supplies Corporation and merely extends to the lower-octane ratings relief from unnecessary regulations previously provided for gasoline of 91 octane and higher.

All the gasoline removed from price control is allocated by government authority.

-CASING APPLIED WITH A TROWEL!
IN THIS modern Detrick furnace wall each element is used most effectively: suspended refractories for heat protection; insulation for holding heat, and steel for support. The casing, applied with a trowel directly to the back of the insulation, forms a tight, strong, permanent enclosure which is also weatherproof.
NO STEEL CASING KEYED IN PLACE WEATHERPROOF

Notice how the block insulation backs up the refractory and the casing is applied directly to the insulation . . . all held in place by the light wall support.

As the need for more efficient and economical furnace enclosures develops, Detrick engineers are ready with designs that effect savings in labor and materials in erection, and costs in operation.

Ask for our new catalog, ready soon, showing applications of Detrick Suspended Walls to all types of boilers and oil heaters.

M. H. DETRICK COMPANY

140 South Dearborn Street **Chicago**

DETRICK FURNACE ENCLOSURES

Preference Ratings For Industry Raised

Through a revision in P-98-b, the War Production Board has raised the preference rating on all materials used by the petroleum industry. With an AA-2x it will be possible to get quicker deliveries than could be had under the A-2 rating, which has been the highest granted the industry.

At the same time, the uncertainty under which the industry has operated because of the temporary character of the P-98 orders previously issued was eliminated by a provision making the new order effective until revoked. The new P-98-b retains the A-2 and A-1-A preference ratings previously granted but adds a much higher rating of AA-2x, all to be applied on the delivery of materials required either (1) for completing alterations involving the use of additional materials valued at $500 or less, (2) for materials required exclusively for research with currently available research facilities, (3) for materials necessary for repair maintenance and operating supply purposes, and (4) for materials to be used in any operation directly incident to the discovery, development or depletion of petroleum pools.

The ratings, however, will not be applicable to the acquisition of materials which otherwise are obtainable on the date required; the use of which can be eliminated by substitution of less scarce materials or by changes of design that will not seriously reduce operating efficiency in excess of a 90-day supply, or restricted or prohibited by other orders or regulations of the WPB or of equivalent authority in Canada.

PAW officials explained that the new order contains only three major changes from the previous regulations, the higher preference rating now available, the extension of preference ratings to materials for alterations up to $500 and the provision of ratings for materials for research.

Inventory Sales

WPB also issued an amendment to Preference Rating Order P-98-c, permitting the sale of inventory stocks of materials by an oil operator to an oil industry supplier for direct resale to another operator.

The original order provided only for the sale of stocks by one operator directly to another. And the amendment, it was said is designed to permit supply houses to negotiate sales and deliveries of materials between operators, acting in the capacity of brokers.

Applications for priorities on materials are being cleared through the PAW in three days or less, as the result of a streamlining of the process which gives district offices authority to handle applications for small quantities without reference to Washington, it was reported December 30 by Deputy Administrator Davies.

Davies said that during October, the five district offices and the Canadian Oil Controller's office countersigned some 9600 applications under P-98-b for materials valued at about $950,000, an average of $99 per application, while the Washington office approved 364 applications for $1,098,428 worth of materials, an average of $3017 per application.

Summarizing activities during the last week of November, he said the Canadian Oil Controller's office and the PAW organization in Washington and in the field handled 2334 certificates with a value of $4,427,652, of which about 71 percent in number and 32 percent in value was under P-98-b and 27 percent in number and 40 percent in value under PD-1A.

Project authorizations on PD-200 covered only about two percent of the number but 27 percent of the value of all authorizations. An additional 47 PD-1A certificates representing a value of $153,000 were issued for foreign consumption.

Approximately 17 percent of the certificates and 42 percent of the value was for raw materials, as compared with 83 percent of certificates and 58 percent of value for fabricated products.

THE LOOK BOX

Midgley Is ACS President-Elect

Thomas Midgley, Jr., vice president of Ethyl Corporation and a director of Ethyl-Dow Corporation, has been chosen president - elect of the American Chemical Society. He will succeed to the presidency of the society in 1944.

Per K. Frolich, president-elect in 1942, is now president of the society. He is director of the chemical division, Esso Laboratories, Standard Oil Development Company, Elizabeth, New Jersey.

Midgley has been a director of the society since 1930 and chairman of the board since 1934.

Harrison E. Howe Dies in Washington

Dr. Harrison E. Howe, editor of Industrial and Engineering Chemistry, died at his home in Washington, December 10. He had been editor of this publication of the American Chemical Society for 21 years and was active in other editorial work of the organization.

He was born in Georgetown, Kentucky, and attended Earlham College, Richmond, Indiana, after which he studied at the University of Michigan and at the University of Rochester. He was with Sanilac Sugar Refining Company and Bausch & Lomb Optical Company before becoming associated with Arthur D. Little, Inc., Boston, and its Canadian affiliate, as assistant to the president and manager of the industrial department.

During the first world war he was a consultant in the nitrate division of the Ordnance Bureau, United States Army. In 1919 he became chairman of the division of research extension of the National Research Council. He left this position in 1921 to become editor of Industrial and Engineering Chemistry.

Industry Checking Manpower Situation

Oil-company and trade-association officials have been asked by the special PIWC Manpower Committee to make full reports on the effects on their organizations of the loss of men through the selective service and through transfer to other industries, with a view to developing a basis for recommendations to the council which will insure adequate manpower for the industry.

The investigation was authorized at the December PIWC meeting and a committee composed of John M. Lovejoy, chairman; Sidney Belither; J. W. Carnes; N. C. McGowen and J. Howard Pew was appointed by Chairman Boyd.

In asking the industry for information the committee pointed out that while it recognizes that every industry is affected seriously by the war and that vast realignments of manpower are inescapable, "Nevertheless, this is an oil war and the first requirement for its successful prosecution is the delivery of petroleum products where and when needed, both for military purposes and for essential civilian use."

While statistics covering the loss of men to the military service and to other industries will be helpful, it said statements also are desired regarding the loss of efficiency in the various operations—whether more men are now required than formerly to do a given job—whether men are leaving to accept jobs less important, etc.

Each branch of the industry it was pointed out, has activities of particular importance under present conditions and a number of them were listed with a request that they be given special consideration in making reports.

W. M. McElroy Heads Refining Department

W. M. McElroy has been appointed manager of the refining department of General Petroleum Corporation, Los Angeles. This promotion marks another advancement in his connection with the

W. M. McELROY

company with which he has been associated for more than 25 years.

McElroy is a native of San Jose, California, who went to work for General Petroleum Corporation in the Taft field, following school years at Santa Clara University. Three years later he went to Mexico to represent the company and spent two years in refining work at Tampico.

Upon returning to California he spent a short time at the Vernon plant as a pipe fitter and later served as estimator and then foreman of the construction department at Vernon. Since 1923 he has held such positions as constructor, field constructor, assistant engineer, fire-prevention and control engineer, assistant refining superintendent, and more recently assistant manager of the Vernon and Torrance plants.

Utilities Association Holds Annual Election

J. C. Happenny of Oklahoma Power & Water Company was elected president of Oklahoma Utilities Association at a recent meeting. E. C. Joullian of Consolidated Gas Utilities Corporation was elected first vice president, George McLean of Oklahoma Gas and Electric was named second vice president, while D. S. Kennedy of the same company was elected treasurer.

New directors elected to serve a three-year term are Glenn C. Kiley of Oklahoma Gas & Electric Company and Frank B. Long of Oklahoma Natural Gas Company. Those elected for a one-year term are J. P. Arnold of Public Service Company of Oklahoma, C. A. Breitung of Southwest Natural Gas Company, George A. Davis of Oklahoma Gas & Electric Company, J. C. Happenny and R. K. Lane of Public Service Company of Oklahoma. Holdover directors include E. C. Joullian, A. F. Potter, Gas Service Company, S. I. McElhoes, Southwestern Light & Power Company, and W. L. Woodward of Zenith Gas System, Inc.

Accident Frequency Rate Improves

Despite a larger number of participating concerns the average accident frequency rate of the petroleum section of the National Safety Council showed a 3-percent drop over previous contest.

The average frequency rate for all contest divisions was 8.88 reportable injuries per 1,000,000 man-hours worked.

Manufacturing units had the lowest rates, averaging 5.42. Drilling units had the highest rates with an average of 41.68.

Seventeen contestants in various divisions went through the year without a single reportable accident.

Frequency rates for the seven contest divisions and the change from the previous contest follow:

Division	Average Frequency Rate	Percent Change, 1940-41
Manufacturing	5.42	+8
Natural Gasoline	7.25	+16
Wholesale Marketing	7.80	—4
Oil & Gas Pipe Line	8.53	—3
Retail Marketing	13.32	—8
Producing	13.54	+1
Drilling	41.68	—5

R. W. Gallagher Elected President Jersey Company

R. W. Gallagher was elected president of the Standard Oil Company of New Jersey, January 6, succeeding W. S. Farish, who died November 29. His selection as president involved the peculiar procedure of relinquishing the post as chairman of the board, which will not be filled at this time. He had been elected board chairman in November upon the retirement of Walter C. Teagle.

Gallagher spent the early part of his business career with natural gas interests controlled by the oil company. He became a member of the board of directors of Standard Oil Company of New Jersey in December, 1933, when he was president of East Ohio Gas Company. His duties then came to be direction of the several affiliated companies whose activities were primarily in the natural gas field.

When he was 16 years of age the death of his father forced him to find work and New York Transit Company provided the opportunity. After four years with this concern, National Transit Company and United Pipe Lines he went to Akron, Ohio, as shop foreman of East Ohio Gas Company. Thereafter he served in many capacities and in 1908 became superintendent.

Fetherston Assumes Active Military Duty

Franklyn R. Fetherston, secretary and treasurer of both the Compressed Gas Manufacturers' Association and its affiliate the Liquefied Petroleum Gas Association, Inc., has been granted leave of absence while on duty with the United States Army. He has been assigned to the resources division, Service of Supply, Washington.

Ruggedness and dependable accuracy, too, distinguish the ALL-METAL THERMOMETER

Readability in an indicating thermometer is an outstanding advantage *if* full dependence can be placed on each reading. Thus the WESTON thermometer has been widely adopted throughout the process industries: because it provides both these essential factors . . . readability and dependability . . . without compromise. It's simple, all-metal temperature principle . . . minus gases, liquids, capillary and involved mechanisms . . . assures "on-the-dot" accuracy over a far longer period of time. In addition, this all-metal construction safeguards against failures due to vibration or over-ranging. *You're more certain of your reading . . . with a* WESTON.

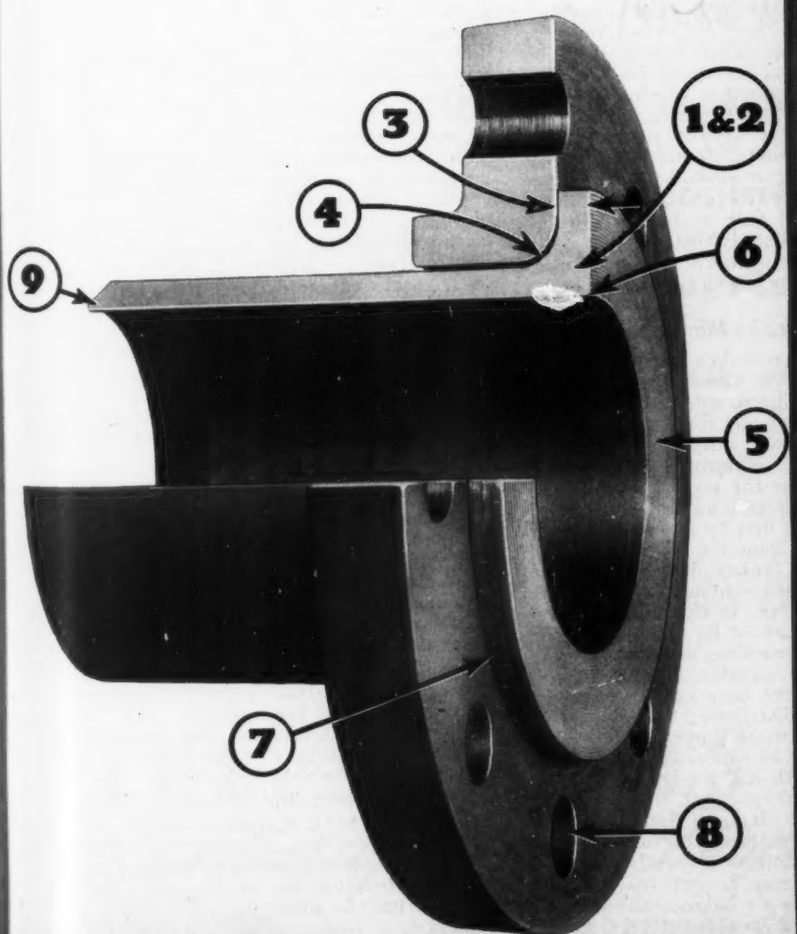
WESTON all-metal thermometers are supplied in types and diameters for most industrial applications and in stem lengths from 2½ to 24". Accuracy, over the entire scale, guaranteed within 1% for the industrial models . . . ½ of 1% for the laboratory model. Literature gladly sent on request, although production facilities are at present devoted solely to the war effort. Weston Electrical Instrument Corporation, 655 Frelinghuysen Avenue, Newark, N. J.

WESTON ALL-METAL *temperature Gauges*

MIDWEST

LAP-JOINT STUB ENDS

Have MANY ADVANTAGES



1. LAP IS FORGED—by a special Midwest process that simultaneously upsets the pipe and forms the lap. Tests have proved the superiority of this process.

2. STRESS RELIEVED—The metal in the lap is worked at a forging heat and then normalized to assure a uniform, close-grained structure. Photomicrographs show it frequently superior to the original pipe material.

3. HEAVY LAP—Thickness of finished lap (after machining front and back) is always at least equal to pipe wall thickness.

4. LARGE RADIUS FILLET—Assures more metal in the critical area of lap—where maximum total bending and shearing stresses occur. Advantages 3 and 4 are important factors in securing the greatest strength in the lap.

5. PHONOGRAPHIC FINISH—of lap face holds the gasket more securely.

6. SQUARE CORNER (instead of a round corner)—adds to lap strength but also eliminates pockets for accumulation of condensate and sediment that promote corrosion.

7. UNIFORM FLANGE BEARING—Back face of lap is carefully machined to assure the uniform flange bearing necessary to a satisfactory joint.

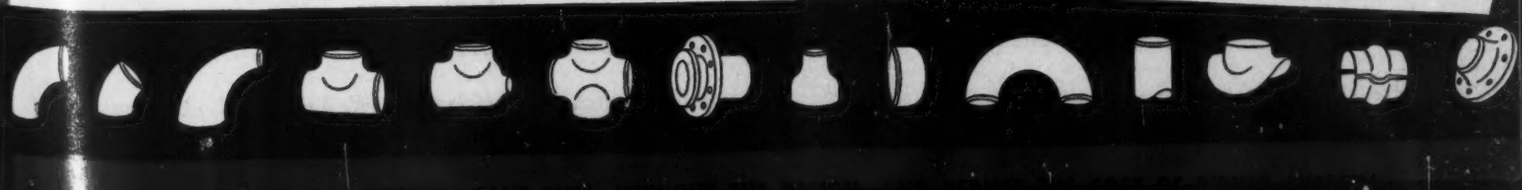
8. TIME SAVED—in both welding and erection because bolt holes need not be carefully lined up before welding.

9. MACHINE BEVELED—The other end of the Stub End is accurately machined for easy welding.

See Bulletin WP-41 for complete data on Midwest Lap-Joint Stub Ends . . . and the other Midwest Welding Fittings that simplify and save on welded pipework.

MIDWEST PIPING & SUPPLY CO., Inc.

Main Office: 1450 So. Second St., St. Louis, Mo.
Plants: St. Louis, Passaic (N. J.) and Los Angeles
Sales Offices: Houston—229 Shell Bldg. • Tulsa—533 Mayo Bldg.
Chicago—949 Marquette Bldg. • Los Angeles—520 Anderson St.
New York (Eastern Division)—30 Church St.
San Francisco—535 Call Bldg.



PIWC Sees Crude Requirements Up 400,000 Barrels During 1943

DEMAND for crude oil will increase by not less than 400,000 barrels a day by the end of the coming year, PIWC was told at its monthly meeting December 8 by its committee on petroleum economics.

In a report submitted by Chairman Robert E. Wilson, the committee emphasized the necessity for increasing producible crude-oil reserves and called upon the Army to submit some estimate of its requirements from the Pacific Coast beyond the first half of 1943, so that provision can be made to supply any necessary increases in that area.

At the same time, it was declared, a long-range supply-and-demand program for the West Coast should be formulated to obtain information for a comparison of steel for drilling in California against the steel requirements that would be needed to increase supplies from other parts of the country, such as a pipe line from New Mexico.

In the Eastern territory, the committee foresaw a further shortage in supplies unless a very unlikely increase in tanker deliveries can be achieved and warned that despite restrictions on gasoline and fuel oil consumption there probably will be an additional shortage in District 1 of 50,000 to 100,000 barrels daily, bringing East Coast stocks to dangerously low, if not absolutely unworkable, levels before the end of the winter.

However, the committee said, further decreases in heating-oil rations may not be necessary if "immediate and drastic" steps are taken to reach the objectives of the present rationing program.

For the four months ending next March 31, the committee estimated deliveries into District 1 by means other than tanker will average 1,142,000 barrels daily, while total demand, local and export, on a rationed basis will be 1,384,000 barrels, a shortage of 241,000 barrels of which at least 154,000 barrels must be made up to attain a minimum stock level of 52,000,000 barrels on March 31.

Leaves Deficit

This 154,000 barrels deficit should be made up by ocean tanker deliveries, the report said, but the PAW estimates of such deliveries are for only 94,000 barrels daily and that figure might be reduced to as little as 50,000 barrels, corresponding to deliveries by vessels suitable only for limited coastwise service, by possible needs for additional tankers for other service. Thus, it was pointed out, a shortage of 60,000 to 104,000 barrels must be faced this winter, even after more drastic rationing.

While more stringent rationing of gasoline and forced conversions to coal have reduced the estimate for domestic consumption in the district by 130,000 to 140,000 barrels daily, all but approximately 75,000 barrels of the savings will be absorbed by an increase in export requirements for military purposes, it was disclosed.

Although the committee set 52,000,000 barrels as the desirable minimum stock figure for total crude and products in the district as of next March 31, it admitted that recent studies indicate that a lower minimum can be attained under emergency conditions and recommended a more complete investigation to determine what actual minimum levels can safely be reached.

"Any reduction in the minimum figure used as of March 31 will require thorough-going industry cooperation and proper distribution of these stocks by products and between areas in District 1 in relation to demand," it emphasized. "As an offset against this probable decrease in minimum required stocks is the fact that the armed services have recently tended to 'freeze' certain stocks for military purposes which is disruptive of plans to care for other demand also essential to the war effort.

"The committee believes, on the whole, that the relief which may be afforded by any increase in tank-car deliveries, or reduction in stocks below the minimum levels assumed, will be more than offset by the probable lag in securing estimated reductions in local demand. Thus, it would appear that after all of the foregoing allowances, District 1 must face a shortage in the range of 50,000 to 100,000 barrels daily over the winter, unless higher tanker deliveries can be obtained.

Reduce to Minimum

"This situation makes it clear that the use of gasoline for all but essential driving must be eliminated, and that consumption of fuel oils for heating be reduced to the bare minimum necessary for maintenance of public health. Even after this is done the shortages that will remain are both serious and substantial and can only be met by increased tanker deliveries. The question of maintenance or increase of tanker deliveries is one of military policy, outside of the scope of this committee. If the tanker deliveries required cannot be made available, the shortage remaining, after cutting the consumption of gasoline and of fuel oil for heating to the bare minimum possible, should be distributed between gasoline and the various types of fuel oil in such a manner as to occasion the least interference with the war effort."

Increased war product requirements, reduced civilian demand and decreased transportation facilities continue to complicate the problem of crude runs in Districts 1, 2 and 3, and the refinery yields necessary to balance supply and demand without excessive stock accumulations in District 3, the committee reported.

The growth of refinery capacity for critical war products is tending to increase required minimum runs at the plants involved, automatically reducing the runs necessary at the non-war plants to meet essential civilian requirements within the limits of available transportation facilities, it said.

The estimated anticipated runs were set by the report at 573,000 barrels a day for the December-March period in District 1, or 79 percent of the actual of 726,000 barrels for the last six months of 1941; 1,125,000 barrels in District 2, or 99 percent of the 1941 actual of 1,131,000 barrels, and 1,260,000 barrels in District 3, or 85 percent of an actual of 1,482,000 barrels.

"It is only possible to achieve the operating program outlined because of the marked change in the proportion of the different products required in District 3, as the outlet for District 3 to District 1, as limited by the estimated available transportation, is some 90,000 barrels less than previously forecast," the report explained. "The principal change is the anticipated diversion of part of the residual fuel oil requirements from the Gulf to other sources. This program of the district committees will also require a product stock accumulation over the winter of 75,000 barrels daily in District 3, 58,000 barrels daily of which will occur in gasoline stocks. This accumulation will lessen flexibility necessary to maintain the production of essential war products, and while supplying essential civilian demand, particularly railroad fuel oil from refineries in the interior of District 3. Even after these stocks accumulations, the approximate balance indicated is precarious as changes in product requirements, especially of residual fuel oil, would create an impossible condition. Relief from this situation can only be obtained by reallocation of refinery runs and transportation facilities among the three districts.

"The table of anticipated yields indicates that substantial changes are necessary in current operations, and if these changes are not made, on the basis of the crude runs estimated, there will be a substantial over-production of gasoline, with a corresponding reduction in necessary supplies of distillate and residual fuel oils."

For the first time, it was pointed out, operations in District 5 are included in the forecast, but are covered only for the first six months of 1943 because estimates of military requirements are not available beyond that period.

It is important, the committee held, that estimates of military demand be made available for a longer period if the industry is to maintain itself in an adequate position to supply such demand as may be made upon it.

So long as tanker capacity is available for supplying requirements of the Pacific Northwest, the demand forecast can be adequately supplied from sources within the district, the council was told. The ex-

13,200 TIMES GRAVITY

Do you realize that such force is available for commercial *day-in-and-day-out* use in Sharples Centrifuges? Could you use it to step up production—to increase yields—to improve quality? Sharples engineers have a vast experience, especially in the petroleum industry, in using this great centrifugal force. Can they serve you?

THE SHARPLES CORPORATION

Centrifugal and Process Engineers

ARMY E NAVY

2335 WESTMORELAND STREET · PHILADELPHIA · PA.

LONDON · PARIS · NEW YORK · BOSTON · PITTSBURGH · CLEVELAND
DETROIT · CHICAGO · DALLAS · SEATTLE · SAN FRANCISCO · LOS ANGELES

SHARPLES

Representatives throughout the world

WHEREever you find a high degree of efficiency in filtering operations and fabrics are the filtering media, you will find a high degree of fabric uniformity for once the proper fabric construction has been determined then filtering efficiency and fabric uniformity go hand in hand. That is why from the selection of top grades of cotton to their last final inspection, we exert such eternal vigilance in the production of MT. VERNON Extra filter fabrics. That is why day by day we continue to add to our more than fifty years industrial fabric making experience by endeavoring to make MT. VERNON Extra filter fabrics better, stronger and more highly uniform than ever before.

MT. VERNON WOODBERRY MILLS, INC.

TURNER HALSEY COMPANY
Selling Agents
40 WORTH STREET * NEW YORK, N. Y.
CHICAGO · NEW ORLEANS · ATLANTA · BALTIMORE · BOSTON · LOS ANGELES · SAN FRANCISCO

isting inter-district movements of crude and products between District 5 and District 4 are only a small percentage of total supplies in the former and are sound from the standpoint of conserving transportation.

"In fact," it was commented, "barring the effect of sudden and drastic changes which might occur under war-time conditions, operations in District 5 would appear to be practically independent of operations in other districts."

There are, however, two possibilities of changes which might involve other sources of supply: (1) the loss of all or a substantial part of present available tanker capacity to the Pacific Northwest and (2) a sudden large and confused increase in military requirements, particularly for Navy fuel oil.

Because the supply of the Pacific Northwest is largely dependent upon tanker deliveries, as rail facilities are limited, ocean movements in that area save more tank cars than do vessels supplying the Atlantic seaboard, it was explained, and there are probably military reasons for maintaining and operating a reserve of tankers on the Pacific Coast, which would make it appear that they should be the last tankers to be withdrawn from coastwise service.

"While adequate rail deliveries are available from District 4 to the Pacific Northwest, comparatively little shut-in production exists in District 4," the committee said in a discussion of the situation. "The only possibility of increasing supplies in District 4 would be by drilling up so-called 'black oil reserves,' the production from which is satisfactory fuel oil without processing. Price levels and transportation costs are such that this supply would in no wise be an economic source under normal conditions. Consequently, provision of funds and necessary critical materials for developing this source of supply as a reserve for emergency use would be purely a government matter. Thus, assurance of continuity of supply of a substantial portion of the Pacific Northwest requirements is essentially a military question, the decision as to whether provision should be made for tanker supply or steel and capital should be expended for developing reserves in District 4 resting with the proper government authorities.

"In regard to the question of sudden large and continued increases in military needs, it should be pointed out that District 5 could, for a period of time, meet large increases in military requirements. This is possible only because of the existing large above-ground stocks of residual fuel oil. Some shut-in potential crude-oil production exists which could be readily converted into products required for military use. Liftings of products for military use are currently running below estimated requirements, and to the extent that this continues, reserve stocks will be higher than those forecast. On the other hand, for the longer term, existing wells could not maintain even the existing rates of production, and additional drilling is definitely necessary before these above-ground stocks are depleted below safe levels."

The supply of Navy fuel oil and other military requirements from the district involves the least expenditure of critically limited transportation, so that obviously all possibilities of local supply should be exhausted before consideration of alternatives outside the district. Estimates of the necessary steel expen-

SHAW PIPING

Engaged 100% in War Production of

PIPING PREFABRICATION AND INSTALLATION

TO meet America's great war needs . . . plants are expanding, new ones are being built. In this vital construction work — piping of all sorts, shapes and sizes is needed. To speed these piping installations, Shaw maintains, in addition to its home plants, a complete and highly skilled field force with complete facilities for doing fast, efficient work, right on the job. Thus work moves faster — vital time is saved.

Since 1893, Benjamin F. Shaw Company has specialized in prefabricated piping. To meet the demands of the country at war — Shaw brings to every job undertaken — the skill resulting from fifty years of experience.

Our engineering staff is available to you on any piping problem. We invite your inquiry.

Specializing in Piping for

- ★ ORDNANCE WORKS
- ★ SYNTHETIC RUBBER PLANTS
- ★ AVIATION GASOLINE PLANTS
- ★ POWER & EVERY TYPE OF PROCESSING PLANTS

Geo. W. Stewart

Sales Manager

BENJ. F. SHAW COMPANY

2nd & Lombard Streets, Wilmington, Delaware

PIPING FABRICATORS, CONTRACTORS AND DISTRIBUTORS

diture to augment California supplies from outside the district have been made by a subcommittee to serve as a measuring stick in comparison with the necessary steel expenditure in the state to supply equivalent volumes of products but, the committee suggested, steel for drilling in California is probably more readily available than tanker or pipe-line steel which would be required for development of outside supplies, so that on anywhere near a break-even basis it would doubtless be preferable to develop existing reserve sources within the state.

In this connection, the committee called the attention of the Navy to the desirability of serious consideration of the development of existing California Naval reserves, which would provide substantial reserve production capacity with relatively low expenditure of steel, to meet possible substantial increases in requirements for Navy fuel oil.

To provide a basis for comparison of steel expenditures for drilling in California with the steel requirements from alternative sources, the committee recommended that a forecast supply-and-demand program for District 5 be projected over the year 1943 and probably longer. "This program," it pointed out, "would serve as a basis for the necessary crude-oil production studies, a large part of which have already been made, of the amount of steel required for the drilling necessary to meet forecast requirements, and, as a special case, the expenditure of steel and time required to make adequate provision for increases in military requirements. The top limit of production in this case would be that corresponding to total available refinery capacity, plus allowance for potential production of some heavy crudes suitable for use as fuel oil without processing.

"With this program established it would then be possible, by a comparison of steel requirements for drilling in California with steel expenditures for increasing and transporting oil from sources outside of the district, to determine whether or not alternative sources should receive any further consideration, or whether attention should be solely concentrated on the development of California supplies for the total of all scheduled requirements, plus possible increases up to the limit of refinery capacity. The time indicated as necessary for additional drilling in California to meet possible increases up to the limit of refinery capacity would serve as a basis for establishment of adequate stock levels of crude and individual products to meet emergency conditions. These stock levels, together with estimates of demand, would then provide a defensible basis for the necessary month-to-month schedules of crude-oil production in California to meet requirements.

"If it is impossible to secure estimates of military demand for an adequate period, it is suggested that the forecast be based on estimated civilian demand, plus a continuation of the present estimates of military demand. Such a forecast would make clear to those responsible for forecasting military demand the importance of supplying adequate estimates of military requirements. It would also furnish to them the information as to time and steel expenditure necessary to make adequate provision in advance for possible additional requirements for military use."

Total demand in the fourth quarter of 1943 will reach 4,670,000 barrels a day while total supply, as now estimated, will be but 4,452,000 barrels, the committee said in its nation-wide forecast. The definite figures are shown in the following tabulation:

	4th Quarter, 1942 (Partly Estimated) Thousands of Barrels Daily	4th Quarter, 1943 (Estimated) Thousands of Barrels Daily
Total U.S. Crude Production	3,912	4,185
Natural Gasoline and Other Supplies	234	267
Total Supply	4,146	4,452
Local plus Export Demand for Crude and Products	4,213	4,670
Change in Stocks—Total	—67	—218
Crude Oil	+13	—111
Products	—80	—107
Total U.S. Refinery Runs	3,769	4,204

Thus, the committee pointed out, it will be necessary to produce over 400,000 barrels more crude per day a year hence if we are to meet demand without drawing on stocks, but continuance of current trends of declining discoveries and waning ability to produce substantial additional quantities from existing reserves without waste "may find the industry unable to produce sufficient crude oil without waste to meet its war requirements before the war is over."

Refinery Yields[1]

	(Figures in Percent Yields)		
	Year 1941	4 Weeks Ending Nov. 21, 1942[2]	Projected Dec.1942-March, 1943
District I			
Gasoline (inc. Av.)	39.4	37.1	37.2
Kerosine	4.7	5.4	6.7
Distillate Fuel	17.6	16.2	17.4
Residual Fuel	21.2	22.4	20.1
All Other	17.1	18.9	18.6
Total	100.0	100.0	100.0
District II			
Gasoline (inc. Av.)	52.2	44.5	39.3
Kerosine	5.0	6.1	6.5
Distillate Fuel	10.3	15.5	15.9
Residual Fuel	18.5	19.7	23.4
All Other	14.0	14.2	14.9
Total	100.0	100.0	100.0
District III			
Gasoline (inc. Av.)	44.4	39.2	37.3
Kerosine	7.3	5.9	6.7
Distillate Fuel	14.2	19.3	19.4
Residual Fuel	22.1	23.8	22.4
All Other	11.0	11.8	14.2
Total	100.0	100.0	100.0
District IV			
Gasoline	50.6	47.1	45.7
Kerosine	2.5	1.4	2.5
Distillate Fuel	8.4	13.7	11.1
Residual Fuel	22.7	27.2	28.4
All Other	15.8	10.6	12.3
Total	100.0	100.0	100.0
District V			
Gasoline	33.9	28.8	30.5
Kerosine	1.0	0.8	1.3
Distillate Fuel	13.0	11.1	11.8
Residual Fuel	41.4	46.8	47.3
All Other	10.7	12.5	9.1
Total	100.0	100.0	100.0
Total U. S.			
Gasoline	44.2	38.7	36.7
Kerosine	5.1	4.8	5.5
Distillate Fuel	13.4	15.1	16.3
Residual Fuel	24.3	26.8	27.4
All Other	13.0	14.6	14.1
Total	100.0	100.0	100.0

[1] Yields based on total refinery input, exclusive natural and unfinished gasoline; residual fuel yield includes liquid fuel oil burned by refinery.

[2] Gasoline, distillate, and residual derived from average of last four weekly figures. Kerosine based on last available B. of M. figure (Sept.) and others by difference.

On the basis of its report, the committee recommended that since indicated supplies to District 1 are inadequate to meet even the reduced demand, the council recommend that PAW call the attention of OPA to "the even more serious situation which will result if these estimated reductions in local demand in District 1 are not promptly realized," and repeated its November recommendation for a careful study to determine the lowest reasonable level to which stocks in District 1 can be reduced during the shortage period, with the suggestion that District 2 now be included in the survey.

The committee pointed out that the present method of handling fuel-oil inventory and ration coupons is likely to result in an undue drain upon primary suppliers' stocks and a failure properly to draw down surplus distributors' stocks by the end of the critical shortage period, and recommended that means be found whereby distributors' stocks be reduced after the turn of the year in accordance with the normal seasonal pattern and built up thereafter in accordance with good operating practice, or as supplies permit.

Other recommendations in the report were as follows:

"In view of the declining trend of production in District 2 and the acute shortage of crude oil stocks which already exists in the eastern part of District 2 (where such stocks are down to approximately 9.5 days' supply) it is believed that before any increased shipments of crude oil are required from District 2 to District 1, the relative efficiency of such shipments, taking into account actual point of origin, should be compared with shipments from District 3. There are many areas in District 3 from which additional tank car shipments can be made with efficiency substantially equal to that from Oklahoma. It is recommended that the transportation division of OPC investigate this matter thoroughly in determining the most desirable sources of increased shipments of crude to District 1.

"Increased crude-oil production requirements during the year 1943 emphasize the paramount importance of increasing producible crude oil reserves.

"The committee recommends that some estimate of military requirements to be supplied from District 5 be provided by the proper authorities beyond the first half of the year 1943 in order that adequate provisions for meeting possible increases in such demands may be incorporated in subsequent programs. This is part of the general important question of securing adequate estimates of military requirements from all supply areas.

"The committee recommends that the formulation of the long-range supply-and-demand program and necessary collateral studies as above outlined be carried out by the proper agencies in District 5, so that adequate information will be available for the comparison of steel expenditure for drilling in California to meet military demands with the steel requirements of increasing supplies from points outside of the district."

A number of current problems were brought up for discussion at the meeting—prices, manpower, the transformation of OPC to PAW, the East Coast situation—and several resolutions were adopted, one expressing the sorrow of the council over the death of William

DOW INDUSTRIAL CHEMICALS

SERVING AMERICAN INDUSTRY FOR HALF A CENTURY

Numbered among more than 500 Dow chemical products is an important group of industrial or heavy chemicals. Bromine and bromides were Dow's first contribution to the advancement of domestic chemical production. The bromine processes were soon adapted to the manufacture of chlorine. Shortly after 1889, a new field, that of producing chlorinated products such as sulphur chloride, carbon tetrachloride, etc., was added. In turn, the manufacture of Caustic Soda led to new processes for producing aniline, phenol, indigo and other organic compounds.

Thus from a meager beginning, has come a tremendous production capacity for chemical products of quality and dependability.

THE DOW CHEMICAL COMPANY, MIDLAND, MICHIGAN

New York · Chicago · St. Louis · Houston · San Francisco · Los Angeles · Seattle

DOW

CHEMICALS INDISPENSABLE
TO INDUSTRY AND VICTORY

FIRE and how to fight it!

HOW OFTEN SHOULD EXTINGUISHERS BE RE-CHARGED?

Is your fire-fighting equipment in good condition—ready for a sudden emergency? Even the finest portable extinguishers cannot retain full effectiveness indefinitely. Some day one of your extinguishers may be called on to save your plant. Insure reliability of your fire-fighting equipment. Follow the simple rules charted below.

		DO THIS ONCE EACH YEAR	WILL IT FREEZE?
CARBON DIOXIDE		Weigh to detect leakage. If extinguisher shows loss of weight of less than 10% of rated capacity, stamped on label, nothing need be done. Recharge if weight loss shows greater than 10%.	no
SODA ACID		Discharge and refill. Mix soda solution outside extinguisher, following manufacturer's instructions. Use lukewarm, not hot water. Wash all parts with water. Examine for clogging or corrosion.	yes — Do not keep outdoors in cold weather.
PLAIN WATER		Inspect by removing and weighing carbon dioxide cartridge. Replace cartridge if weight loss exceeds ½ ounce. Inspect hose and nozzle for clogging or corrosion, and check the quantity of water.	See label for this information.
FOAM		Recharge. Mix solution outside the extinguisher according to manufacturer's exact directions. Wash all parts thoroughly with water. Test hose. Examine for corrosion or clogging.	yes — Do not keep outdoors in cold.
VAPORIZING LIQUID		Test by partially discharging. Pump a few strokes with extinguisher first aimed upward and then downward. Replace lost liquid, as furnished by manufacturer.	no
DRY COMPOUND		Remove and weigh carbon dioxide cartridge. Replace if it shows loss of weight of more than ½ oz. for 12 lb. extinguisher or 1 oz. for the 20 lb. size. Check quantity of dry compound and determine that it is free-flowing.	no
CARBON DIOXIDE SYSTEM		Weigh cylinders to check loss of contents. Blow out carbon dioxide lines. Check all releases, thermostats, tubing, switches, pull boxes and electric lines.	no

MORE EFFECTIVE FIRE FIGHTING

Since December 1941 Walter Kidde and Company has had an unusual war job . . . to make products that save fighting men's lives. These products include high pressure containers for aviation use, special type built-in extinguishing systems, crash trucks and various flotation equipment.

Since we have fewer Kidde extinguishers* to sell, we are trying to make your existing fire-fighting units more effective

If you want reprints of this series of advertisements, just write to

Walter Kidde & Company, Inc., 117 West St., Bloomfield, N. J.

Kidde

*Formerly known as "LUX" extinguishers

NOTE: *Recharge extinguishers immediately after use, even though only partially expended.*

S. Farish. Outling Farish's achievements, the resolution said "His record of service to his country and the oil industry is a long one," recalling that in the last war he was a member of the National Petroleum War Service Committee.

"During the present war he was untiring in his devotion to his country's service, and insisted that the interests which he represented make full and patriotic contribution," it declared. "He took an active part in every war program sponsored by the council, and served actively as chairman of its important committee handling wartime problems related to the organized, nation-wide protection of the oil industry's facilities.

"The petroleum industry war council hereby records its appreciation of the services rendered by William Stamps Farish to the industry and to the nation, and extends to his family, friends, and business associates its sympathy in this mutual loss."

The executive order establishing PAW was discussed with the council by Administrator Ickes, with members of the group taking the occasion to express their gratification over his continuance at the head of the work.

Ickes, however, did not let the friendly congratulations of the PIWC sway him from his course, and told the members bluntly that the oil companies would have to speed up their handling of tank cars.

A discussion of the price situation resulted in adoption of a recommendation of the production committee for an exhaustive study of the crude-price structure "with a view to determining those factors which can be expected to stimulate an increase in the rate of discovery of new reserves." With this information in hand, it was pointed out, the industry will be in position to support any application to OPA for an increase in prices.

The council also set up a new technical committee, with Dr. Robert E. Wilson as chairman and Robert H. Colley and W. S. S. Rodgers as members, to plan and supervise the work of the technical advisory subcommittee which is working with PAW in the development of the technological program of refining for increased production of war products.

In a resolution, the council authorized Chairman Boyd to appoint a five-man committee to confer with Ickes and War Manpower Commission Chairman Paul V. McNutt on the many manpower problems of the industry.

The council also adopted a resolution asking PAW to issue a directive eliminating retail credit cards and in other ways restricting the extension of credit by suppliers and dealers, effective January 1.

F. H. Garner Now at Birmingham University

F. H. Garner, who was connected with Esso European Laboratories, London, has been appointed to the professorship of oil engineering and refining at the University of Edgbaston, Birmingham, England.

His appointment followed the death of Professor A. W. Nash in 1942.

WESTINGHOUSE OIL-IMMERSED LINESTARTERS INSTALL ON THE JOB faster STAY ON THE JOB longer

Conduit work and conduit fittings are reduced to a minimum with Westinghouse Oil-immersed Linestarters. Conduit is brought straight to the starter from any direction. Wiring may be carried straight through. There's plenty of room inside and out for gloved hands to work while snaking in wires and making connections. Pressure connectors speed wiring and eliminate hazards from soldering.

Maintenance is reduced, too. Oversize heavy copper contacts carry heat away faster, naturally last longer. All parts are readily accessible, and arranged for easy inspection . . . with positive safety.

Completely weather-proof and dust tight, Westinghouse Oil-immersed Linestarters are made for across-the-line starting of squirrel-cage motors.

For complete details, call your local Westinghouse representative or write for descriptive data. Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., Dept. 7-N.

J-21229

Westinghouse

OIL-IMMERSED MOTOR STARTERS FOR CORROSIVE AND EXPLOSIVE ATMOSPHERES

Committees Named for Joint Facilites Use

Members of the subcommittees which will work out details for joint use of facilities within the petroleum industry have been named for the several districts. Those serving in refining, natural gasoline and natural gas in four of the districts are:

District 1: Refining: C. R. Barton, chairman, Tide Water Associated Oil Company, New, York; Wilbur F. Burns, Socony-Vacuum Oil Company, New York; Robert H. Colley, The Atlantic Refining Company, Philadelphia; Aubrey D. David, Bradford Penn Refining Corporation, Clarendon, Pennsylvania; Arthur E. Pew, Jr., Sun Oil Company, Philadelphia; William A. Slater, Gulf Oil Corporation, Pittsburgh; Chester F. Smith, Standard Oil Company of New Jersey, New York; G. H. Taber, Sinclair Refining Company, New York; W. S. Zehrung. The Pennzoil Company, Oil City.

Natural Gas and Natural Gasoline: D. F. Hartson, chairman, Republic Gas Company, Pittsburgh; J. H. Isherwood, Allegheny Gas Company, Fort Allegheny; Dan S. Keenan, Carnegie Natural Gas Company, Pittsburgh; T. H. Kerr, Ohio Fuel Gas Company, Columbus; R. N. Parks, Virginian Gasoline & Oil Company, Charleston; Loring L. Tomkin, Hope Natural Gas Company, Clarksburgh, West Virginia; Earl D. Wallace, Petroleum Exploration Company, Lexington; H. A. Wallace, Jr., United Fuel Gas Company, Charleston; G. E. Walker, United Natural Gas Company, Oil City.

District 2: Refining: C. L. Henderson, chairman, Vickers Petroleum Company, Wichita; O. E. Bransky, Standard Oil Company (Indiana), Chicago; Reid Brazell, Leonard Refineries, Inc., Alma, Michigan; H. W. Camp, Cities Service Oil Company, Bartlesville; D. E. Hart, Gulf Oil Corporation, Toledo; G. W. Henneken, Standard Oil Company of Ohio, Cleveland; R. R. Irwin, Socony-Vacuum Oil Company, Kansas City; W. B. Logan, The Texas Company, New York; C. B. Watson, The Pure Oil Company, Chicago.

Natural Gas and Natural Gasoline: A. W. Ambrose, chairman, Cities Service Oil Company, Bartlesville; C. V. Daniel, Oklahoma Natural Gas Company, Tulsa; J. G. Dyer, Continental Oil Company, Ponca City; E. V. Kesinger, Natural Gas Pipe Line Company, Chicago; J. A. LaFortune, Warren Petroleum Corporation, Tulsa; T. J. Strickler, Kansas City Gas Company, Kansas City; W. C. Taggart, Taggard Brothers, Inc., Big Basin, Michigan.

District 4: Refining: Henry D. Moyle, chairman, Wasatch Oil Refining Company, Salt Lake City; C. C. Buchler, Standard Oil Company (Indiana), Casper; F. N. Fortin, Yale Oil Corporation, Billings; E. S. Holt. Utah Oil Refining Company, Salt Lake City; E. A. Markey, Continental Oil Company, Denver; H. S. McCray, The Texas Company, Sunburst, Montana; E. M. Parkin, Glacier Production Company, Cut Bank; F. L. Perry, Perry Petroleum Company, Denver; M. H. Robinson, Frontier Refining Company, Cheyenne.

Natural Gas and Natural Gasoline: Robert W. Hendee, chairman, Colorado-Interstate Gas Company, Colorado Springs; J. T. Bishop, Wyoming Gas Company, Basin, Wyoming; E. B. Coolidge, Hard Rock Oil Company, Great Falls, Montana; J. M. McIntire, Northern Utilities Company, Casper; F. T. Parks, Public Service Company of Colorado, Denver; J. D. Roberts, Mountain Fuel Supply Company, Salt Lake City; Clarence J. Shortess, Wyoming Gas Company, Denver; Cecil W. Smith, Montana-Dakota Utilities Company, Minneapolis; E. D. Smith, Glacier Production Company, Butte, Montana.

District 5: Refining: W. L. Steward, Jr., chairman, Union Oil Company, Los Angeles; L. F. Bayer, Tide Water Associated Oil Company, San Francisco; F. S. Flulow, Shell Oil Company, San Francisco; S. J. Dickey, General Petroleum Corporation, Los Angeles; R. G. Follis, Standard Oil Company of California, San Francisco; A. M. Kelley, Richfield Oil Corporation, Los Angeles; Maurice A. Machris, Wilshire Oil Company, Los Angeles; B. O'Connor, The Texas Company, Los Angeles; H. S. Rothschild, Rothschild Oil Company, Santa Fe Springs.

Natural Gas and Natural Gasoline: O. C. Field, chairman, O. C. Field Gasoline Corporation, Los Angeles; C. D. Card, Union Oil Company, Los Angeles; M. L. Fort, Pacific Lighting Corporation, Los Angeles; H. R. Linhoff, Richfield Oil Corporation, Los Angeles; Stuart Magor, Superior Oil Company, Los Angeles; F. S. Magruder; General Petroleum Corporation, Los Angeles; N. H. Mull, The Texas Company, Los Angeles; T. L. Taggart, Standard Oil Company of California, San Francisco; R. S. Tulin, Shell Oil Company, Los Angeles.

Phillips Moves Philgas Division

General offices of Philgas Division, Phillips Petroleum Company, have been removed from the General Motors Building, Detroit, to company headquarters at Bartlesville, Oklahoma. The transfer was made to permit closer correlation of policy and operation problems. In explaining the transfer, K. S. Adams, company president, said:

"So far as the move affects our customers and suppliers it is merely a change in mailing address. Essentially the same key personnel will be at the new location and no changes in operating methods are involved.

"The Detroit tank car section of Philgas Division will continue the present district sales and service office in the General Motors Building, similar to the other district offices now maintained at New York, Philadelphia, Chicago, Milwaukee, St. Louis, Bartlesville and Amarillo. The Detroit district office is under the direction of W. F. DeVoe."

Branch Offices of PAW Are Announced

District branch offices of the Office of Petroleum Administrator for War have been opened in Pittsburgh and Tulsa. The Chicago headquarters of District 2 is now at 625 South Michigan Avenue.

The branch office at Pittsburgh is in room 700 Benedum-Trees Building. Stationed there are Virgil Howyer of the natural-gas and natural-gasoline division, and Henry W. Fuelhart of the production division.

The branch office in Tulsa is at 410 Beacon Building, where three men are stationed, C. D. Brown, production division; Mark S. Patton, natural-gas and natural-gasoline division, and Silas R. Clinkscales, materials division.

Inventions Will Go To the Government

Inventions developed by employes of the Department of the Interior while on government time or with government equipment hereafter will be assigned to the federal government under conditions set forth in a formal order by Harold L. Ickes, secretary. The order further defines the rights and obligations of employes of the department with respect to inventions and establishes a uniform procedure to handle assignment of patent rights and encouraging inventors within the department. The policy was made a general condition of employment.

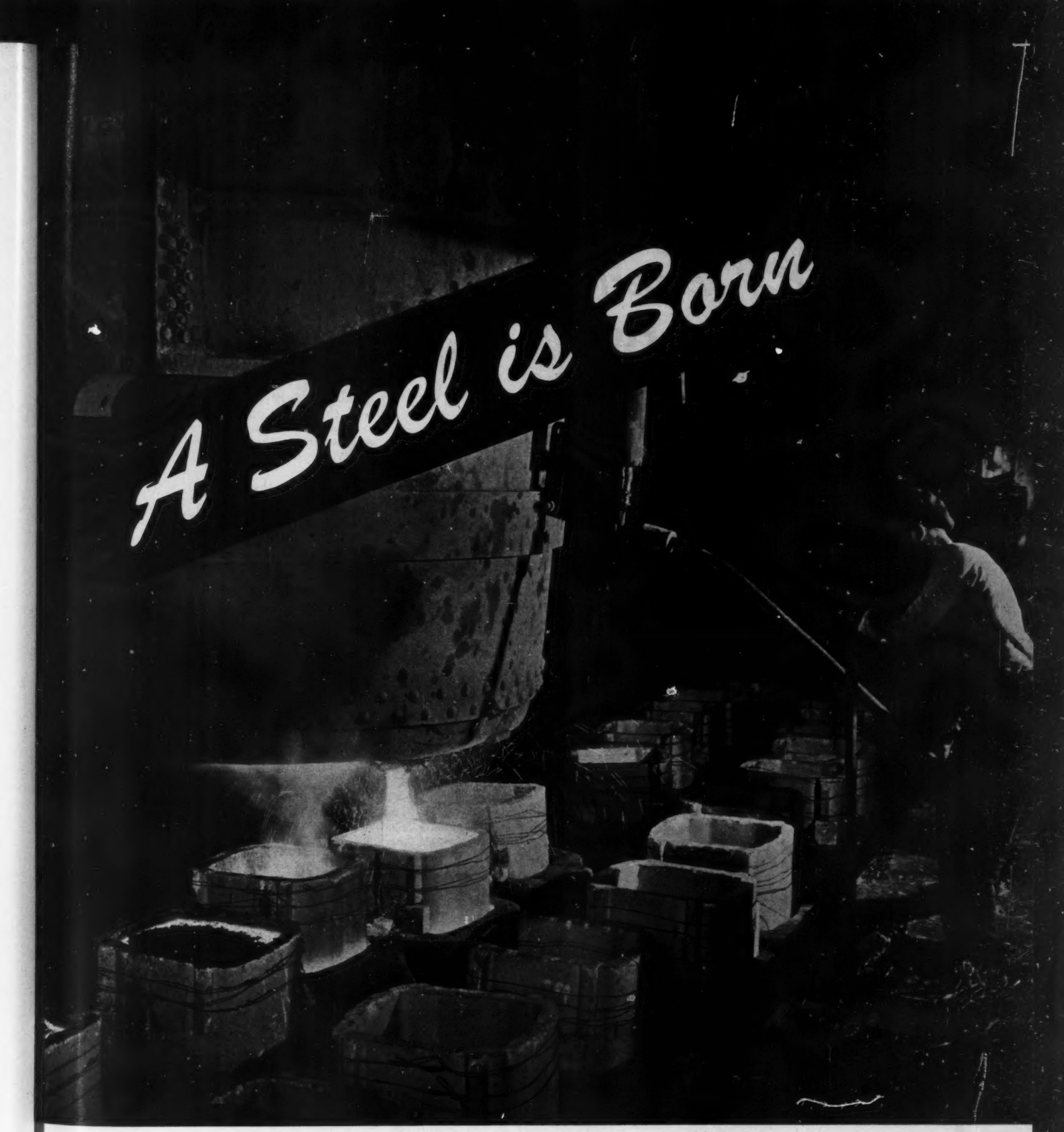
"The government, as the employer and as the representative of the People of the United States, should have ownership and control of any invention developed in the course of governmental activities," Secretary Ickes stated. "Therefore, each employe of this department whose duties are concerned with research or investigation is required to assign to the United States, all rights to any invention made by him within the general scope of his governmental duties."

The secretary's order gives official recognition to a policy already adopted voluntarily by virtually all of the technical and scientific personnel of the department. For a number of years many Interior Department employes who have made inventions have voluntarily assigned their patents to the government, and others have turned over their patents for the duration of the war to the government and to the war industries.

In addition to the former practice of turning over their patents to the government and the war industries for the duration of the war many departmental technicians have voluntarily turned over their patents to the government heretofore, although they were not required to do so. A review of departmental records reveals nearly a hundred patents and several pending patents to which the department's employes had been personally entitled under existing legislation and court decisions have been fully assigned to the government. In addition to patents voluntarily turned over to the government, the government has shop rights in many others held by departmental employes, particularly in the fields of mining, metallurgy, engineering chemistry, explosives and petroleum drilling, refining and transportation. Some of these are outstanding patents which have large existing value, or prospective value.

Among the patents most recently turned over to the government, although this procedure at that time was not required, was that of W. C. Schroeder and A. A. Berk, two Bureau of Mines employes. This patent covers methods of treating water to prevent bursting of boilers and is vital to the war industries. The department can grant licenses on any or all of these patents for their use by commercial and industrial enterprises.

Effective at once, the secretary's new order applies to all future inventions, all inventions which are in the process of development and have not yet been reported to the department, and it is effective without regard to existing or future contracts entered into by employes of the department with any party other than the government. An agreement to assign patent rights to the gov-



Pouring the first heat of a new "A.W." Alloy Steel is a moment to long remember. The promise of Victory and the vision of a better America are in every hot top ingot. Our first thought today is to produce the best steels possible in the greatest volume for ships, tanks, guns or the equipment which produces them. If you are engaged in war production and have an alloy steel problem, we will do our best to help you. Personal attention has been the keynote of "A.W." service since 1826.

ALAN WOOD STEEL COMPANY

MAIN OFFICE AND MILLS: CONSHOHOCKEN, PENNSYLVANIA : SINCE 1826. District Offices and Representatives: Philadelphia, New York, Boston, Atlanta, Buffalo, Chicago, Cincinnati, Cleveland, Denver, Detroit, Houston, St. Paul, New Orleans, Pittsburgh, Roanoke, Sanford, N. C., St. Louis, Los Angeles, San Francisco. Seattle, Montreal.

with **PALMER**

"Red-Reading-Mercury"

THERMOMETERS

Safe fuel is vital to our war effort. You can be certain of correct cracking and processing temperatures with precision-made Palmer "Red-Reading-Mercury" Thermometers. Finest materials and workmanship assure dependable accuracy and extra years of long life. Wartime conditions often delay shipments of our raw materials. But war or peace, you can always rely on Palmer for the best possible service. See Data page 451 of your Refinery Catalog or write for complete catalog No. 7000-B.

THE PALMER CO., Mfrs.

Industrial, Laboratory, Fuel and Recording Thermometers

3113 Gerard Ave., Cleveland (Harvard) Ohio Canadian Plant: King & George Sts., Toronto

See Sectional Directory for Sales Representative

★ ★

CHEMICAL DISTILLATION EQUIPMENT

We are proud that Hicks' Chemical Distillation Equipment is doing its part in aiding industry in the war effort.

√*STILLS*
√*TOWERS*
√*EVAPORATORS*
√*KETTLES*
√*PRESSURE VESSELS*
√*EXTRACTORS*

S. D. HICKS ENGINEERING CO., INC.

Engineers and Designers of Chemical Distillation Equipment

1671 HYDE PARK AVE., HYDE PARK, MASS.

ernment is also made a condition for future employment in the Interior Department under the order.

The protection under an Act of March 3, 1883, of individual rights resulting from an invention made outside the general scope of governmental activities is assured by Secretary Ickes, whose order clearly defines inventions developed on government time and those developed independently of federal assistance.

"An invention," the order stated, "will be considered within the general scope of governmental duties of an employe under the following conditions:

"(1) When an employe's duties include research or investigation, or the supervision of research or investigation, and the inventions arose in the course of such research or investigation and is relevant to the general field of an inquiry to which the employe was assigned.

"(2) When the invention was in substantial degree made or developed through the use of government facilities or financing, or on government time, or through the aid of government information not available to the public."

While the department wishes to encourage and recognize individual achievement in research and investigation, employes who made inventions outside the scope of their government duties can receive assistance according to the secretary's order. Such inventions will be reviewed as to their merits and bearing upon the public good, and may be patented by the government in an individual's name, and to his benefit and without cost to the individual, provided the invention is available for manufacture and use by the government without the payment of royalties.

Inventions developed under federal auspices also will be reviewed by the secretary who may determine that the interests of the United States do not require a full assignment of the patent rights to the government.

Asserting that the department will do all within its power under the existing restrictions to reward its employes who advance the technological and scientific knowledge of the nation, Secretary Ickes said that legislation to permit additional rewards would be proposed to Congress as advisable. "The department also will give energetic consideration to the establishment of machinery to further the use by industry and the public of the inventions conceived in the department and assigned to the government," the order added.

In setting up a system for reporting inventions made in the various bureaus and agencies of the department, the Secretary's order provides that each invention considered to be patentable must be reported to the head of the bureau, with a description of the nature and operation of the invention, the circumstances under which it was developed, and the inventor's opinion as to the relative rights of the government and the employe. If the inventor believes that it should be patented under his own name in accordance with his rights under existing federal law, he must make a statement to this effect. The department then can take the necessary steps to assure the submission of appropriate patent applications to the patent office and the execution of the assignment of license.

B&W welcomes difficult jobs in heavy steel fabrication

Jobs ordinarily presenting difficulties in heavy welded steel fabrication gravitate naturally to Babcock & Wilcox. The unmatched experience in such work and the unduplicated production facilities of B&W frequently produce savings of time, steel and money not otherwise obtainable.

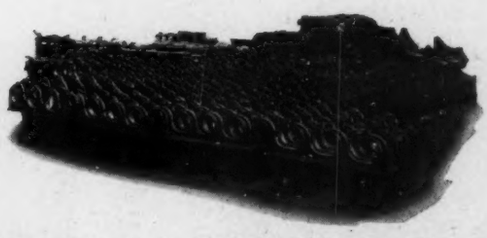
① Showing start of rolling 4" shell plate with ends bulldozed to correct finished diameter.

② Showing completion of rolling 4" shell plate.

③ Showing finished drum course with pushout. Design working pressure, 1375 lb. per sq. in.

Showing a hemispherical head with pushout made from 6¼" plate. Design working pressure, 2650 lb. per sq. in.

Part of a 35,000-pound shipment of tube support castings for oil refinery. 25% chrome—12% nickel.



B&W STREAMLINED OPENINGS

Made by the B&W pushout method of construction, in which all reinforcing is forged and drawn from the parent metal, B&W streamlined openings avoid unnecessary stress concentration, permitting lighter construction with safety.

B&W ALLOY TUBE SUPPORTS

B&W experience in the development and installation of heat- and corrosion-resistant alloys is applied with outstanding success to the production of alloy tube supports and other alloy castings.

S-33-T

BABCOCK & WILCOX

VESSELS. DRUMS. CASTINGS. FORGINGS

FOR HIGH-TEMPERATURE, FOR HIGH-PRESSURE SERVICE

THE BABCOCK & WILCOX CO., 85 LIBERTY ST., NEW YORK, N. Y.

Report Reviews Bureau Of Mines Expansion

Activities of the Bureau of Mines have been greatly expanded during the past year in the fields of strategic minerals and petroleum to aid in the production of war essetnials, it is disclosed in a report by Director R. R. Sayers.

While more than doubling its output of helium for military and civilian uses, Sayers reported, the bureau has begun construction of additional facilities to multiply by many times the 1941 output and to exceed greatly the record 1942 rate of production. To assure a continued supply of the gas, surveys have been made for additional plant sites, and bureau engineers are continuing studies designed to reduce production costs.

At the request of OPA, petroleum and natural gas engineers are developing means for utilizing most efficiently the various components of 100-octane aviation gasoline, determining the quantity and nature of hydrocarbons from high-pressure fields for use in the manufacture of high explosives and aviation gasoline, stimulating recovery from shallow oil fields with a minimum use of steel, evaluating the sources and means of obtaining war materials from petroleum including butadiene, and conducting special studies at six field stations to provide solutions to technical problems of oil producers.

In anticipation of the time when the nation's oil reserves may be unable to supply essential needs, bureau chemists have speeded up their progress on the production of motor fuels and lubricants from domestic coals. Since the attack on Pearl Harbor, Sayers declared, the bureau has completed assays of 14 American and Alaskan coals to determine their suitability to liquefaction, obtaining from 35 to 75 gallons of gasoline per ton of coal used, including that utilized in operating the laboratory equipment.

PORTER MIXERS
for Perfect Blending
FAST · TROUBLE-FREE · ADAPTABLE
Compact, sturdy, quickly installed and adjusted, Porter Mixers are readily adaptable to any blending job about the plant. Porter equipment is carefully designed and constructed to operate continuously with a minimum of maintenance. There is a Porter Mixer for every purpose in the refining industry. Catalog and detailed descriptions on request.
SIDE ENTERING MIXERS
For blending and ethylizing gasoline, in large tanks, and for lube blending. All sizes up to 25 H.P.
WHIRLPOOL PORTABLE MIXERS
For quick blending of fuel oils, special oils, etc. Can be moved easily from one tank to another. Geared and ungeared models in all sizes.
FLANGE MOUNTED MIXERS
For gasoline and low viscosity oils in small tanks. Geared or direct drive types, in a complete size range.
ARMY
E
NAVY
CHICAGO

Federal Oil Tax Collections Way Off

Federal gasoline tax collections in November dropped to the lowest figure touched since July, 1940, totaling only $20,719,050, it was disclosed by the Internal Revenue Bureau.

This month's receipts from this source were approximately $11,000,000 under October, when $31,622,272 was collected and about the same under November, 1941, when they totaled $31,176,356.

Collections from the lubricating-oil tax also declined, amounting to $2,838,-152 against $3,266,338 in October and $6,123,407 in November of last year, but receipts from pipe-line transportation increased to $1,219,101 from $1,113,175 in the preceding month and $1,166,256 in the corresponding month of 1941.

The bureau's report showed that gasoline restrictions in the East and generally curtailed driving in other parts of the country already has cost the Treasury nearly $40,000,000 in taxes. The gasoline-tax revenue for the 11 months ended with November was but $308,-231,571 against $341,487,599 for the same period last year, and income from lubricating oil was $36,404,102 against $42,258,607.

Taylor Is Shell Vice President

J. F. M. Taylor has been elected vice president of Shell Oil Company and will have supervision of manufacturing operations in the territory east of the Rocky Mountains. His election followed an indefinite leave of absence granted to E. D. Cumming, who is serving as director of refining under the Petroleum Administrator for War.

Mexican Expropriation Now Closed Chapter

Years of controversy over the expropriation of American oil properties became a closed chapter and the "all is forgiven" flag was hung out December 23 in a reciprocal trade agreement with Mexico in which the 50 percent cut in import-oil taxes accorded Venezuela under a similar agreement was extended to Mexican crude petroleum and fuel oil, but without any quota restrictions.

In justification of its action in abandoning quota limitations on imports of Mexican oil, the State Department explained that during 1940 and the first nine months of 1941 imports from Venezuela, the Netherlands possessions and Colombia, the chief beneficiaries under the Venezuelan agreement, were almost entirely within the quotas assigned to those countries and therefore entered at the reduced rate of tax, while only 15 percent of the imports from Mexico in 1940 and 27 percent of those in the first nine months of 1941 were within the quota, and the remainder were subject to the full tax.

Malice in Thunderland

From the heat of battle has come a speed-up in the amazing contributions of the petroleum industry to America's war effort. And now, even some of the "dreams" of petro-chemistry are rapidly approaching reality.

One of these is a new "plastic glass" lighter than glass, crystal clear, and harder than other clear plastics. Though a carefully guarded secret, this much can be told: With heat treating it will be "best yet" for aircraft gun turrets because it resists abrasion and scratching so that visibility is maintained. Cloth or paper soaked in it to make laminated plastic boards, valuable in airplane fuselages, is a possibility.

While many of petro-chemistry's newest contributions are death-dealing today, peacetime applications will bring much greater developments. That means expansion for the petroleum industry. And that's where OSTUCO can do its part in the future as it has in the past—with condenser, heat exchanger, boiler, superheater and other seamless steel tubing arteries in refinery operation. You'll find that OSTUCO experience with new steels, new specifications, new speed requirements will provide a material advantage in speeding output and lowering costs.

THE OHIO SEAMLESS TUBE COMPANY

SHELBY OSTUCO OHIO

SCIENCE AND TECHNOLOGY

Abstracts prepared in co-operation with the

PETROLEUM REFINER

by

THE LESLIE LABORATORIES

Traver Road, Ann Arbor, Mich.

under the supervision of

DR. E. H. LESLIE and DR. H. B. COATS

The abstracts here presented are selected from the current literature of science and technology to afford reference to fundamental information not easily available to all readers. Abstracts of articles appearing in readily obtainable trade journals are not included.

Photostat copies of original articles will be supplied at cost by the Leslie Laboratories. Complete or limited bibliographies covering special topics by title, by abstracts, or in complete manuscript, will also be prepared and furnished at reasonable cost by the Laboratories.

Fundamental Physical And Chemical Data

An Equation for the Isotherms of Pure Substances at their Critical Temperatures, C. H. MEYERS, *J. Res. Natl. Bur. Standards* **29** (1942) pp. 157-76 (Res. Paper No. 1493).

An empirical equation is presented for data along the isotherms of pure substances at their critical temperatures and at densities up to 1.1 times the critical density. The equation contains 5 constants in addition to the universal gas constant. Of these, one is limited to a single value, three are determined by critical conditions, and the remaining one is determined from data other than those for the critical state. The equation was found to represent the data for 12 out of 13 substances within the experimental error. The exceptional substance was water. The fugacity along the isotherm can be calculated from the equation. The fugacity at the critical state is approximately two-thirds the critical pressure for all substances. The fugacity of carbon dioxide was calculated for one atmosphere and at the critical pressure.

Chemical Compositions And Reactions

Bacteria Attacking Petroleum and Oil Fractions, R. W. STONE, M. R. FENSKE AND A. G. C. WHITE, *J. Bact.* **44** (1942) pp. 169-78.

Cultures capable of attacking crude oil, lubricating oils, petrolatum, asphalt and all other petroleum fractions were isolated from garden soil. The light and medium weight fractions are more susceptible of attack than the heavy viscous portions, and paraffins are attacked more readily than aromatics. The reactions involve oxidation, and are characterized by a high bacterial count, emulsification, and sometimes a decrease in pH. Light oils take up more oxygen than heavy oils, and aromatics more oxygen than paraffin. The CO_2 to oxygen ratio for the dissimilation of light oils is approximately 0.65, but much lower for heavy oils. The organisms were all motile Gramneg. rods, Pseudomonas, and many white mucoid types. They were found in all soil samples tested and appear to be of common occurrence. The bacteria did not exhibit a specific ability to attack one type of oil, but rather had a capacity to adapt themselves according to conditions to attack any particular oil with which they came in contact.

The Cyclization of Hydrocarbon Mixtures, S. J. GREEN, *Jour. Inst. Petr.* **28** (1942) pp. 179-208.

The conversion of non-aromatic hydrocarbons into aromatics within convenient temperature range constitutes one of the most important advantages in recent hydrocarbon chemistry. Considerable work has been done on the dehydrogenation-cyclization reactions of pure hydrocarbons, but little has been published on the conversion of hydrocarbon mixtures. Two different processes are understood by the terms "thermal" and "catalytic" aromatization. The thermal aromatization of heptane, for example, would lead to an equilibrium mixture of benzene and other aromatics, while the cyclization of the same hydrocarbon would produce toluene. The author reviews the literature on the production of aromatics from unsaturates, from paraffins, from naphthenes, and from hydrocarbon mixtures. He considers the literature with reference to the mechanism of the reactions involved in dehydrogenation-cyclization. Previous work on catalysts is considered, as well as on the thermodynamics of the reactions. The apparatus used in conducting the experimental work is described in some detail, as well as the preparation of the catalyst, and the analytical methods used. In cyclicizing n-heptane, using chromium sesquioxide as catalyst, 93 percent of the charged liquid was obtained as a product containing 55 percent of toluene and 40 percent of unchanged heptane. In contrast to this, the cyclization of heptene gave only 14 percent of aromatics. Considerable hydrogenation of technical heptene paraffins accompanied the reactions of dehydrogenation, cyclization, and cracking. Cyclization of mixtures of heptane-heptene was studied. The percentage of aromatics obtained in the product falls off rapids with initial increasing concentration of heptene in the feed. The reactions of toluene were examined under the conditions of cyclization. It was found to be relatively stable, only about 6 percent decomposing. The effect of presence of toluene in heptane-toluene mixtures was studied with respect to cyclization of the heptane. Heptane was converted into toluene in predominantly aromatic mixtures. 2:2:4-Trimethyl pentane was passed over a molybdenum catalyst at 550° C. Twenty-five percent of the charge was converted into aromatics, largely xylene. Over chromium sesquioxide xylene and some benzene were obtained. When benzene itself was treated at 550° C., 98 percent passed through unchanged. The cyclization of mixtures containing sulphur compounds was studied. In order to test the poisoning of the cyclization catalyst by surphur, thiophen was found to be stable, but decomposed to some extent under cyclization conditions. The indication was that the use of cyclization catalysis is possible for the production of pure aromatic hydrocarbons. Some nitrogen compounds likewise are converted into ammonia and hydrocarbons under the conditions of cyclization. A bibliography of 46 references is included.

Studies in Stereochemistry. III. The Preparation of d-1-Deutero-2-Methylbutane and the Study of Its Optical Rotation, H. C. BROWN AND C. GROOT, *Jour. Amer. Chem. Soc.* **64** (1942) pp. 2563-6.

d-1-Deutero-2-methylbutane was prepared from d-2-methylbutanol-1 and examined in a sensitive polarimeter to determine whether a compound of this type exhibits measurable optical activity. It was concluded that the optical activity of the pure hydrocarbon in a 1-decimeter tube is definitely less than 0.005° and probably less than 0.002°. The preparation of the compound is described in some detail, as well as that of the compound d-2-methylbutanol-1 and d-1-chloro-2-methylbutane used in its synthesis.

A Simple Apparatus for Small-Scale Catalytic Hydrogenation, C. R. NOLLER AND M. R. BARUSCH, *Ind. & Eng. Chem.*, Anal. Ed. **14** (1942) pp. 907-8.

Numerous designs of apparatus suitable for small-scale catalytic hydrogenation have been described in the literature. The present authors make no claim for great originality in the apparatus used, but believe that they have combined the good features of several

GINEERING NOTES ON GIRBOTOL GAS PURIFICATION

GAS WITH 4500 GR. OF H_2S PER 100 SCF AND 5% CO_2 PURIFIED FOR COMMERCIAL USE BY *Girbotol Process*

25,000,000 S.C.F. of very sour gas to be purified per day.

Treated gas will be free of H_2S by the rigid Bureau of Standards test

Incidental removal of 5% CO_2 will increase heating value of gas

Accompanying dehydration prevents hydrate formation in transmission system

Recovered H_2S will be converted into sulfur, sulfuric acid or other products

No matter how difficult is your problem, the simple cyclic Girbotol Process will remove and recover acid gases from gaseous mixtures and liquids *more completely* and at *less cost* than any other method known today.

Several Girbotol users are converting recovered H_2S into sulfur and sulfuric acid — valuable by-products, especially in war time.

In the natural gas field, Girbotol plants purify natural gas for industrial and domestic use, eliminate corrosion and hydrate formation in lines and process equipment, for storage in the liquid state, and for many other purposes.

In the refinery field, Girbotol is used to remove hydrogen sulfide and carbon dioxide from refinery gases and liquids for feed stock to polymerization and alkylation plants, recovery of sweet liquid fractions, protection of catalysts against H_2S poisoning, and for the production of hydrogen and liquefied hydrocarbon gases, plus several other uses.

Write today for your copy of a new free book on the separation of H_2S and CO_2 from gases and liquids.

Processes for

Production, Purification, Separation, Reforming or Dehydration of

HYDROGEN SULFIDE
CARBON MONOXIDE
BLUE WATER GAS
ORGANIC SULFUR
CARBON DIOXIDE
HYDROCARBONS
HYDROGEN
NITROGEN
OXYGEN

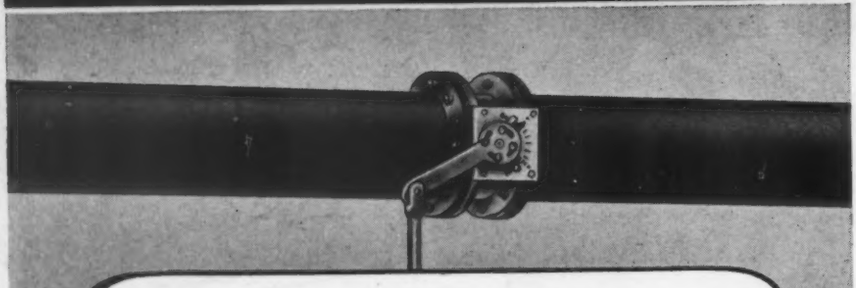
and various mixtures.

The GIRDLER CORPORATION

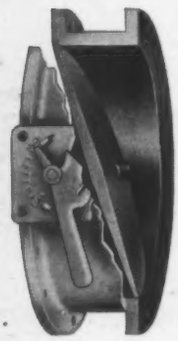
PROCESSES DIVISION • LOUISVILLE KY

SPECIALISTS IN BETTER PROCESSES

Uniform Pressure Obtained in Inaccessible Line



Uniform pressure is obtained on the downstream side of an R-S Butterfly Valve in an inaccessible line by means of an extended reach rod and an electric motor. The declutching unit and hand wheel control is used when the power fails. Can be powered by an air diaphragm motor or hydraulic cylinder.



As the illustration indicates, the beveled vane closes naturally against the body of the valve and at the correct angle for the wedge-tight shut-off of any material that flows or is forced through a pipe. Machined to exceptionally close tolerances.

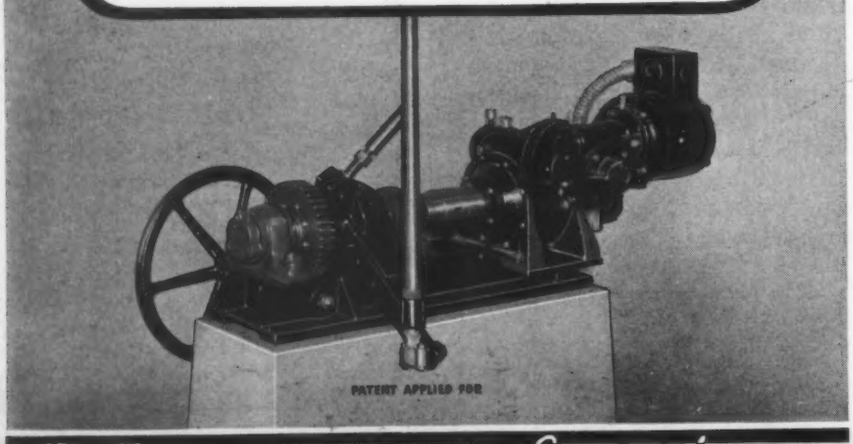
Streamlined construction induces self-cleaning. Maintenance is no problem —constructed to last for years. Sizes to 84-inches and pressures to 600 pounds.

Write for catalog, approximate weights and detailed dimensions.

BUTTERFLY VALVE DIVISION

R-S PRODUCTS CORPORATION

120 Berkley Street Philadelphia, Pa.



R-S Streamlined BUTTERFLY VALVES

types of apparatus and have modified them to give one that is simple in construction and operation. The apparatus is shown diagrammatically, and described in some detail. The weighted sample is placed in the flask with a suitable solvent. A magnetically operated stirrer provides agitation. The apparatus is purged with hydrogen saturated with the solvent. The desired amount of hydrogen is then trapped in the buret, and the buret connected to the flask. Stirring is continued until the volume of hydrogen as read on the buret no longer changes. The catalyst, in solvent, is then added. Stirring is started, and continued until hydrogenation is complete. Although the apparatus has been used only for semimicro work and not for measuring the volume of hydrogen absorbed with great accuracy, there is no reason why the procedure cannot be adapted to micro work.

Analysis of Ethylene in Presence of Butane, J. J. EBERL, *Ind. & Eng. Chem.,* Anal. Ed. **14** (1942) p. 853.

Although the absorption of ethylene in the presence of butane is nonspecific, fuming sulfuric acid has been widely used as a reagent. It has been suggested that concentrated sulfuric acid containing 1 percent of silver sulfate as a catalyst for the absorption of methylene be used. This reagent is, however, not entirely specific in the presence of butane. In order to eliminate the error caused by the absorption of butane a new reagent was developed by the author. This is prepared by adding 12 grams of silver sulfate to 200 cc. of 72 percent sulfuric acid. This reagent absorbs ethylene rapidly and does not absorb butane. A typical set of absorption data for a gas containing 30 percent of ethylene and 70 percent of n-butane are given.

Manufacture: Processes and Plant

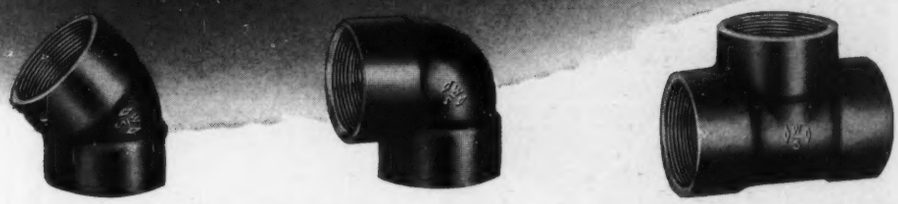
Progress of Styrene Production, WILLARD DOW, *Ind. & Eng. Chem.* **34** (1942) pp. 1267-8.

The first process for the making of styrene involved the formation of ethyl benzene from benzene and ethyl chloride. The ethylbenzene was then chlorinated to yield a mixture of a- and B-chloroethylbenzene. The beta compound was separated and hydrolyzed to give B-phenylethyl alcohol, which was then dehydrated with an alkali to yield a relatively pure styrene. The fundamental difficulty with this process arises from the fact that the chlorination of ethylbenzene normally yields a mixture of monochloroethylbenzenes very high in the alpha compound. The process now in use for making styrene does not involve a chlorination step. Ethyl benzene is produced from benzene and ethylene, using the Friedel-Crafts reaction. Ethylbenzene is dehydrogenated by mixing the preheated vapor of ethylbenzene with highly superheated steam. High yields can be obtained by this procedure without producing free carbon or tar in the condensed reaction product. Considerable difficulty was experienced in developing the purification process, or the separation of the styrene from the other products of cracking. Phenylacetylene, which is formed, must be separated. The styrene monomer polymerizes readily, but the polymerization can be prevented

DEPEND ON THIS

Double Diamond

When you see it on Fittings



WHEN you use Watson-Stillman high-pressure, high-temperature Forged Steel Fittings for *all* of your needs, you can save yourself trouble *now* and save yourself money *in years to come.* The extra endurance of these Forged Steel "heavy-weights" outweighs their cost. That's true economy, true conservation this year and any year.

The Watson-Stillman line includes screwed fittings and socket welding fittings, designed with more than ample metal sections and built with uniform wall thickness.

90 degree elbows, tees, 45 degree elbows, crosses, street elbows, laterals and crosses are forged solid from steel billets. Couplings, reducers, bushings, caps and plugs are machined from solid bars.

Bulletin A-3 lists all available Watson-Stillman fittings.

When you see it on Valves

THE double diamond W-S trade-mark on a valve assures you of the same heavy-duty sturdiness that it stands for when you see it on a fitting.

Watson-Stillman makes bronze and forged steel globe, angle and check valves for high-pressure, high-temperature service, therefore giving you a margin of safety on lower pressures.

New valves have been added to make the line of greater use. Like Watson-Stillman fittings, these valves are available through mill supply distributors.

Bulletin A-4 describes and illustrates these valves.

3133

FREE *Just write us on your business letterhead and ask for Bulletin A-3 on Fittings and Bulletin A-4 on Valves. The Watson-Stillman Co., Roselle, N. J.*

WATSON-STILLMAN

Engineers and Manufacturers of Forged Steel Valves and Fittings, Hydraulic Machinery and Equipment—Hydraulic Presses, Pumps and Jacks

Though Located in the Middle of a Blazing Tank Farm

the Oceco equipped tank was saved

● Seven tanks, ranging from 10,000 bbls. to 80,000 bbls. capacity each, were in this fire which raged, out of control, for more than two days. But one—the only tank equipped with an Oceco Flame Arrestor—came through undamaged, except that the paint was burned off the outside. (The tanks lost were equipped with vent valves only.)

Oceco Flame Arrestors are protecting more than 350,000,000 bbls. of tankage in all parts of the world, but no tight tank equipped to Oceco specifications has ever yet been lost by fire.

The cost of Oceco Flame Arrestors is very small in proportion to the investment they protect. They minimize the dangers of sabotage—reduce fire insurance costs—and are indispensable to companies that carry their own insurance. Our recently completed catalog No. V-50 gives complete details. Send for a copy today.

OCECO

Division of

THE JOHNSTON & JENNINGS COMPANY

885 Addison Road · Cleveland, Ohio

Engineering and Sales Representatives in the Principal Cities

FIRE PREVENTION AND VAPOR CONSERVATION EQUIPMENT FOR VOLATILE LIQUID STORAGE TANKS

by the addition of sulfur. To stabilize styrene polymers, one part in 20,000 of tert-butylcatechol is added. The toxicity of styrene is briefly considered. The same precautions now observed in handling common aromatic hydrocarbon solvents are adequate. A brief comparison is given of the Dow plant method and the methods of others for producing ethyl benzene. Mr. Dow concludes by stating that he looks forward confidently to the future of styrene in the radical improvements of consumer's goods that will be made upon the cessation of hostilities.

Some Fundamental Aspects of Heat Transmission by Radiation from Flames and Furnace Linings, E. C. W. SMITH, A. L. ROBERTS AND D. T. A. TOWNSEND, *J. Soc. Glass Tech.* **26** (1942) pp. 113-29.

The importance of heat transfer by radiation from flames and hot products of combustion and from heated furnace walls is discussed. In the case of nonluminous aerated flames, the principal emitters are water and carbon dioxide molecules that emit selectively. In the case of carbon dioxide a time factor is of some importance. The emission from luminous flames depends upon the presence of carbon aggregates of varying size, and this radiation approximates to black-body radiation. If hydrocarbon fuels are available it is advantageous to work with luminous flames. Refractory materials are intrinsically selective radiators. However, under service conditions their characteristics are so modified as to approach those of a black body. The principles of selective radiation and the possible advantages of its application are discussed with particular reference to certain furnaces used in glass melting. Some difficulty might be encountered in applying the principles stated, but the potential advantages of them are sufficient to justify their experimental investigation.

Progress of Butadiene Production, A. L. ELDER, *Ind. & Eng. Chem.* **34** (1942) pp. 1260-6.

The bottleneck of the present synthetic rubber program is the production of butadiene. The purpose of the author's paper is to present some of the history and technical facts pertaining to the production of butadiene so that the problem can be viewed in the proper perspective. Methods of synthesizing butadiene are first reviewed, including those starting with various hydrocarbons and with monohydric alcohols or dihydric alcohols. No economical method has been developed by which some compound can be fed into one end of the tube and converted into butadiene uncontaminated with substances that involve no separation difficulties. Among the substances that have been proposed for making the separation of butadiene from butenes and other C_4 hydrocarbons are: maleic acid, maleic anhydride, dimethyl phthalate, ethylene chlorohydrin, dichloroethyl ether, glycol acetates, glycol monoethyl ether, lactic acid nitrile, diethyl tartrate, aniline, toluidine, phenyl hydrazine, furfural, water, and acetone. Isobutylene can be separated from butadiene by the use of 65 percent sulfuric acid. Sulfur dioxide forms both crystalline compounds and amorphous compounds with dienes. Butadiene forms a yellow solid compound with a solution of cuprous chloride-hydro-

POWELL *has them all*

The history of the Powell Line is written in the amazing evolution of American Industry, because for nearly a century Powell has been meeting and satisfying every demand imposed by each new process or development in the industrial world.

Big valves, little valves . . . valves for high pressures, low pressures . . . for varying temperatures . . . for corrosion resistance. Globes, gates, checks, reliefs, non-returns, Ys, angles . . . in iron, steel, bronze, pure metals and special alloys—***Powell has them all.***

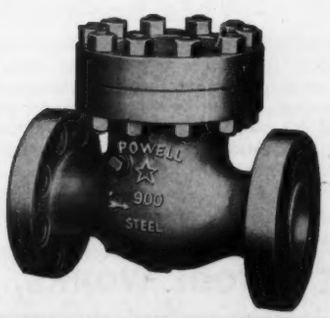
Shown here are a few examples of the many Powell Valves evolved by our Research Engineering Staff to meet some particular requirement. Having completely fulfilled it, they have taken their place in the Powell line.

Today, for every known demand in the Oil industry, whether for pipeline, refinery service or the making of base products for synthetic rubber, Powell has the answer. And, as new problems arise in the future, Powell Engineering will be ready and able to solve them. In either case Powell Quality costs no more in the beginning and saves in the long run.

The Wm. Powell Co.

Dependable Valves since 1846

Cincinnati, Ohio

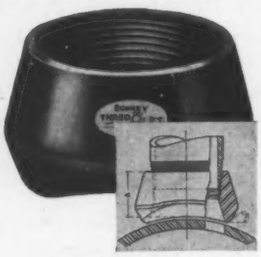


POWELL VALVES

Speed up branch outlet installations without removing the main pipe

These are the fittings that do it

WELDOLET



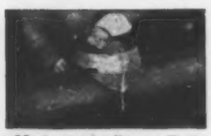
THREDOLET

Socket-End WELDOLET

BECAUSE 90° welded, right-angle branch pipe outlets are made with WeldOlets, ThredOlets and/or Socket-End WeldOlets without any threading, forming and fitting of the main pipe, installation of branch lines is speeded up and cost of installation reduced. Because of their design and ease of application, their installation on existing lines is in many cases possible without even removing a section of the main pipe.

They provide leakproof junctions of full pipe strength, that reduce turbulence and friction to a minimum. Available from stock of drop forged steel for all standard pipe sizes to 12" x 12"—and on special order up to 24" x 24". For special applications they can be furnished in Monel, Everdur, Toncan Iron, wrought iron, etc.

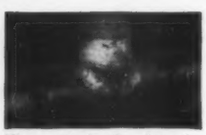
They are easily installed



Mark center lines. Tack the fitting into place. The fitting is the templet.

Then weld the fitting to the main pipe.

Removal of the button permits inspection of the inside of the joint, impossible with any other fittings.



Then attach the branch pipe. A trim, leakproof junction of full pipe strength results.

This book tells how

It tells in detail: their purpose; what they are; how to make welded, right-angle branch pipe outlets stronger, better and at less cost; how they reduce turbulence and friction; how to make a right-angle outlet in six easy steps; how they fill every piping need for new construction or maintenance; their adaptability to shop fabrication, as well as complete tables of specifications and dimensions.

If you use or expect to use pipe fittings for welding, you need this book. Write for it today . . . Bulletin WT31.

BONNEY FORGE & TOOL WORKS, Allentown, Pa.

WELDOLETS·
TRADE MARKS - REG. U. S. PAT. OFF.
THREDOLETS
Welded Outlets for Every Piping System

chloric acid, whereas butylene remains in solution. Heating the solid compound releases the butadiene. Many substances have been proposed as addition agents to the cuprous chloride solution, including ammonium chloride and ammonia. The methods for the production of butadiene that have reached sufficient maturity so that plants have been built, or are in the process of construction, or are in the pilot plant stage, are: (1) thermal cracking plants; (2) catalytic cracking plants to convert butane into butylene and thence into butadiene; (3) ethyl alcohol plants; (4) butylene glycol plants; (5) butyl alcohol plants. If naphtha and light oil feed stock are thermally cracked at 1300-1400° F., some butadiene is produced. The actual yield depends upon the method of attaining the temperature, temperature control, the diluents, the charging stock, and the speed of quenching or cooling. At present four thermal cracking projects are in the program. The estimated production of butadiene from these units is 108,000 tons per year. Catalytic cracking plants involving the charging of butylene or butane, or mixtures, are scheduled to produce 340,000 tons of butadiene per year. Butadiene will be made from alcohol by the well-established Carbide and Carbon Chemicals Corporation process. 220,000 tons of butadiene per year will be made by this method. Eleven units are being built, producing 20,000 tons per year. Each of these units requires 50,000 gallons of alcohol per day. The author concludes with the remark that only a strong and vigorous nation endowed with a wealth of raw materials would have the courage to undertake an output of synthetic rubber of 2500 tons in 1939, 5000 in 1940, 12,000 in 1941, 30,000 in 1942, 325,000 in 1943, and nearly 1,000,000 tons in 1944. Technical men realize that, if improvements in the future developments of synthetic rubber continue as they have in the past, natural rubber at any price may not be able to compete with synthetic rubber.

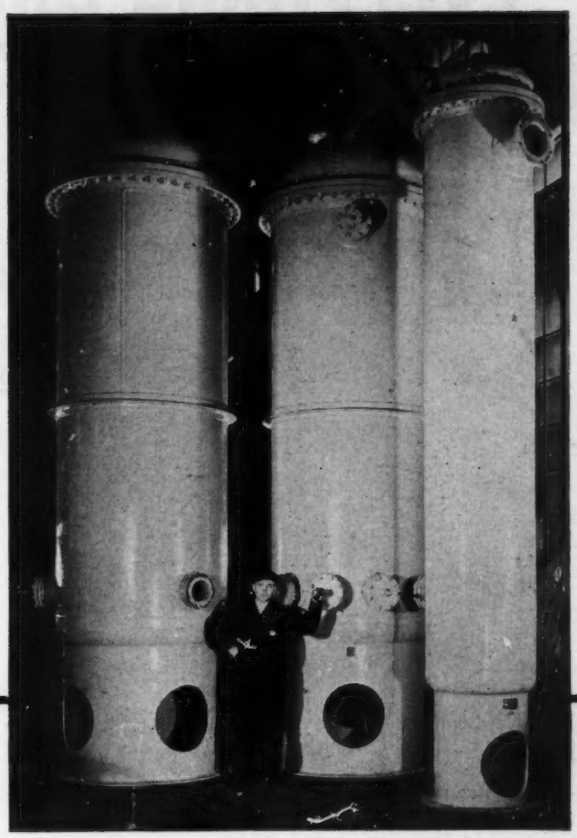
Storage and Containers for 1, 3-Butadiene, *Chem. & Met. Interpretation, Chem. & Met. Engr.* **42** (1942) pp. 117-19.

The article is an abstract of a bulletin published recently by the Pittsburgh-Des Moines Steel Company, through its Chemical Storage Fellowship at the Mellon Institute of Industrial Research, and covering the best container materials, container coatings and proper storage conditions for butadiene. Among the more important variables are: storage temperature, working pressure, and type and capacity of the containers. The report covers the range of temperature between 24° F. and 140° F. Butadiene can be stored in five types of containers: (1) an uninsulated and unrefrigerated spherical container; (2) an insulated and refrigerated container; (3) an insulated and refrigerated double-walled cylindrical container with suspended bottom and dome roof; (4) uninsulated and unrefrigerated horizontal cylindrical container; (5) insulated and refrigerated horizontal cylindrical tank. It is stated that butadiene should preferably be stored in vapor tight, air free containers which are insulated and refrigerated, and which are designed for a working pressure of 3 pounds per square inch gage. Mild steel and welded construction are satisfactory for butadiene con-

They're in the Fight

FOR

Synthetic Rubber Production



These Lectrodryers, part of a constant parade to various war industries, were halted only long enough to have their picture taken. Then on to the job; in this case, a vital DRYing operation in a rubber synthesizing process.

Lectrodryers are DRYing MACHINES for air, gases and many of the organic liquids so important today. Working with Activated Alumina as their drying agent, they remove moisture efficiently and surely to dew points of –110°F. They dry air and gases at atmospheric pressures or compressed to as high as 3,000 pounds per square inch.

For years, Lectrodryers have been becoming a more and more important tool of processers everywhere. Then came the war, demanding greater speed of production, more uniformity in quality. Employing Lectrodryers, manufacturers have met these demands by working in atmospheres of known humidity, with materials of definite dryness.

In your postwar planning, be thinking of the manufacturing economies and improved quality of products possible only with adsorbent drying. Lectrodryers permit the standardization of processes and elimination of hit-or-miss methods, helping to achieve these results. PITTSBURGH LECTRODRYER CORPORATION, 397 32nd Street, Pittsburgh, Pennsylvania.

LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

PITTSBURGH

LECTRODRYER

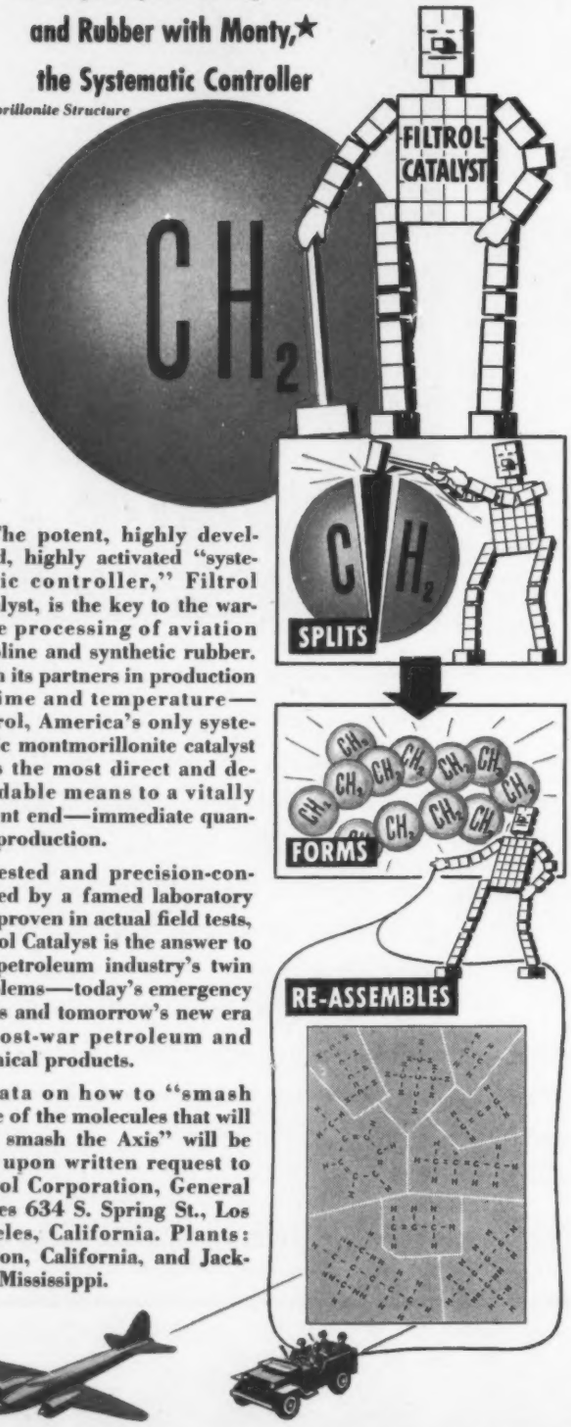
Reg. U.S. Pat. Off.

CORPORATION

Everything Under *Control*

when you synthesize gasoline and Rubber with Monty,★ the Systematic Controller

★*Montmorillonite Structure*



The potent, highly developed, highly activated "systematic controller," Filtrol Catalyst, is the key to the wartime processing of aviation gasoline and synthetic rubber. With its partners in production —time and temperature— Filtrol, America's only systematic montmorillonite catalyst —is the most direct and dependable means to a vitally urgent end—immediate quantity production.

Tested and precision-controlled by a famed laboratory and proven in actual field tests, Filtrol Catalyst is the answer to the petroleum industry's twin problems—today's emergency needs and tomorrow's new era of post-war petroleum and chemical products.

Data on how to "smash more of the molecules that will help smash the Axis" will be sent upon written request to Filtrol Corporation, General Offices 634 S. Spring St., Los Angeles, California. Plants: Vernon, California, and Jackson, Mississippi.

FILTROL CATALYST

to Speed Victory

tainers. It is recommended that mill scale be removed. The chemical properties of butadiene are briefly considered, as well as inhibitors and modifiers. Storage at 32° F. and at a vapor pressure of 3 pounds results in negligible loss of product through dimerization and polymerization and in the lowest initial cost of the storage plant and also the lowest total annual operating cost. The containers should be of maximum size for the total capacity involved.

Butadiene by the Houdry Dehydrogenation Process, C. H. THAYER, E. R. LEDERER AND R. C. LASSIAT, *Chem. & Met. Engr.* **42** (1942) pp. 116-7.

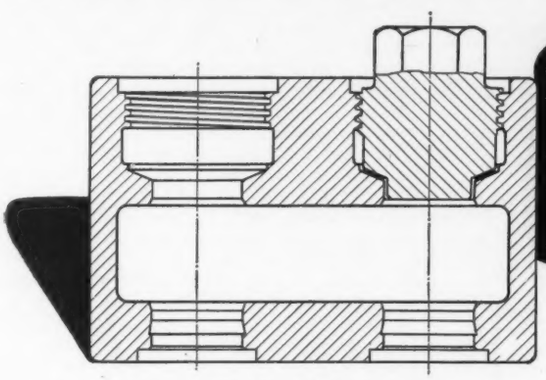
The Houdry two-stage dehydrogenation catalytic process for converting butane or the butane-butylene fractions into butadiene is briefly described. Emphasis is laid on the fact that plants can be converted to operate in accordance with this process, and that construction can be completed within perhaps six months. Butane is the preferred raw material because it is available in large quantities in relatively pure form as a by-product of alkylation processes. n-Butane is available to the extent of at least 175,000 barrels per day. Houdry plants are designed to operate on very short on-stream periods. Each on-stream period is followed by a regeneration step, whereby the carbon deposited on the catalyst is removed and the catalyst is maintained in active condition. The useful life of the catalyst is expected to be more than six months. The utilities required for a Houdry two-stage butadiene plant and purification plant for 15,000 tons per year are: 33,600 kwh per day, 309 barrels of fuel oil per day, 2,000,000 pounds of steam per day, 10,000 g.p.m. cooling water, 300 g.p.m. makeup cooling water. The material requirements for a 15,000 ton plant are itemized, as well as the estimated production cost. The production cost, exclusive of amortization, is 6.4c per pound.

Design and Performance of Cooling Towers, W. K. HUTCHISON AND E. SPIVEY, *Inst. Chem. Engrs.* (London) and *Soc. Chem. Ind.* (London), *Chem. Eng. Group,* Advance Copy, February 10, 1942, 14 pp. *Cf. Ind. Chemist* **18** (1942) pp. 83-8.

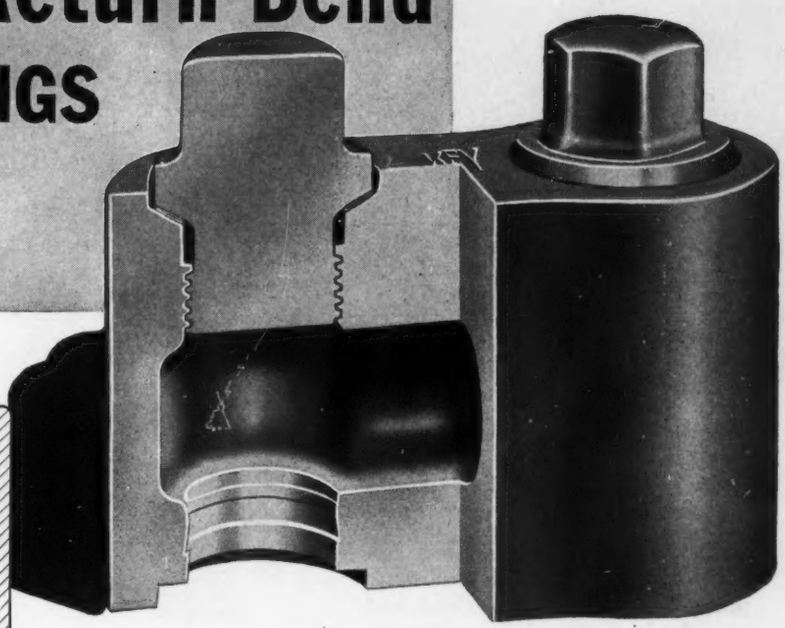
Data are presented for the performance of several industrial and experimental cooling towers of the chimney and forced-draft types. The data for the large industrial towers are reported both as volume coefficients of mass transfer and as "performance coefficients," as B.t.u./(hr.) (sq. ft. of packing cross-sectional are) (°F.). The latter coefficient was found to vary with the inlet water temperature. The packing consisted of horizontal triangular bars of 6-8-inch perimeter, arranged in decks 3 inches apart vertically, with the top faces horizontal, and staggered so that the bars of every fifth deck were in vertical alignment, individual bars being 14-17 inches apart horizontally. Water was distributed over the packing by use of a series of troughs fitted with weirs or nozzles. Data were obtained on an experimental forced-draft tower of 17.4 square feet internal cross section, packed with 11.5 feet of wooden grids. Staggered and parallel arrangements of the grids were studied at varying water

KEY Announces

2 New Return Bend FITTINGS



Type 1700 GB (Gasket at Bottom) for corrosive vapors and liquids.



Type 1700 GT (Gasket at Top) for steam and other non-corrosive vapors and liquids.

Type 1700 GT—has the gasket at the top of the plug and is designed for NON-corrosive use—steam and other vapors—and NON-corroding liquids—This construction advantage permits an absolute minimum of center-to-center measurement.

In connection with its use on steam it has been fully approved by Hartford Steam Boiler Inspection Service.

☆

Type 1700 GB—is designed with the gasket at the BOTTOM of the plug where it protects the threaded section from corrosive action of vapors or liquids. This construction requires wider center-to-center measurement than the Type 1700 GT but it has the advantage of being applicable where corrosion is a factor.

Save Critical Materials Because They Do Not Require Alloy Bolting Stock . . . Simple In Design . . . Fewer Parts . . . Stronger . . . Not A Substitute But A Definite Improvement . . . Meet Many Specific Problems

Here's the answer to hundreds of problems of the industry where Return Bend Fittings are needed. Key Gasket Type Return Bends have been proved and are now in production . . . they are ideal for many installations in the Petro-Chemical as well as the Petroleum Industry.

Study the many advantages noted above—in addition, note that the sealing factor is *not* dependent on the threads—the gasket makes the seal—That means less wrench pressure in make-up—freer fittings at down time.

Let us give you *all* of the details. Write—Wire or Phone Key Company, East St. Louis, Illinois, BRidge 2400 or consult your nearest Key Company District Office.

KEY Refinery Fittings for . . .
CATALYTIC CRACKING . . . HYDROGENATION . . .
POLYMERIZATION . . . ISOMERIZATION . . . REFORMING
. . . ALKYLATION . . . STYRENE . . . BUTADIENE . . . TOLUENE

KEY COMPANY
EAST ST. LOUIS, ILL.

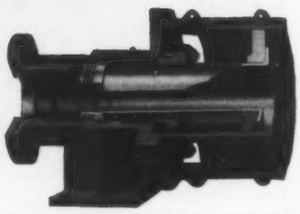
CHICAGO · NEW YORK · PITTSBURGH · TULSA · HOUSTON · LOS ANGELES

Whether you are working on defense contracts or regular production, you cannot afford costly shutdowns in your service lines.

Install ADSCO Piston-Ring Expansion Joints — the slip type joints that can be unpacked and repacked under full operating conditions without interruption to service.

Get all the facts about this modern expansion joint that's always on the job for America's largest industries — Ford — Chrysler — Consolidated Aircraft—U.S. Steel —Carnegie Steel—DuPont—Socony Vacuum—Sun Oil—Armstrong Cork and many others.

Write for quotations, also bulletin 35-15PR.



ADSCO PISTON-RING EXPANSION JOINT

for Steam, Hot Water, Oil or Gas Lines

Piston rings in internal guide hold line pressure during unpacking and repacking operations.

Fully guided by internal and external guide.

Available in single or double joints for high pressures and high temperatures; flanged or beveled ends.

AMERICAN DISTRICT STEAM COMPANY NORTH TONAWANDA, N. Y.

Making "UP-TO-DATE" Steam Line Equipment for over 60 years

ADSCO PISTON RING JOINTS

Can Be Packed Under Pressure

and air rates and inlet wet-bulb temperatures. The coefficient of mass transfer increased as the 0.75 power of the gas rate, aid increased with increasing water rates. Pressure drops were measured for crossed and parallel arrangements of both wet and dry grids. The crossed-grid packing was approximately 3 times as efficient as the triangular-bar packing at the same pressure drop, and approximately twice as efficient at the same power consumption. A propeller-type fan of modern design gave improved mechanical efficiencies. Two large towers designed on the basis of the experimental data gave transfer coefficients agreeing favorably with the experimentally determined values. Experimental water temperatures within 1-4° F. of the atmospheric wet-bulb were shown to be practical.

Products: Properties and Utilization

Classification of Motor Fuels on the Basis of their Cetane Numbers, L. KOHLER, *Oel u. Kohle* **37** (1941) pp. 903-5.

The cetane numbers of several common motor fuels and hydrocarbons were determined by means of the I.-G. test Diesel engine. Using this engine the cetane number can be directly determined within the range 0-100 by changing the compression ratio. This ratio can be adjusted between 7 and 30 to give a constant ignition lag. A definite relationship exists between the cetane number and the compression ratio. Benzene and ethyl alcohol have negative values, while the cetane numbers of power gas and propane are in the vicinity of zero. In general, the ignitability of hydrocarbons rises with increasing molecular weight. The pure or predominantly aromatic fuels are exceptions, the molecular weight and boiling range having little effect on ignitability. Ignitability is increased when the aromatics are hydrogenated, and is still further increased on cracking and hydrogenation to paraffins. Branching of paraffin hydrocarbons lowers the ignitability to a considerable degree. Commercial Diesel fuels have cetane numbers in the range 30 to 55.

Fuels and Lubricants for U. S. Army Motorized Ground Forces, G. A. ROUND, *S. A. E. Jour.* **50** (1942) pp. 267-75T.

The need for simplifying the supply problem is stressed by the author. The ground forces use practically every type of engine, and it is important to reduce the wide variety of fuels and lubricants recommended in civilian use for these various engines. Condensed Army specifications are given for motor fuel, Diesel fuel oil, all-purpose lubricating oil, gear lubricant and greases. The development of these specifications and the problems arising in the case of each class of product are discussed.

The Influence of Bearing Metals on the Aging of Oils. P. BEVERLEIN AND K. W. KRYWALSKI. *Oel u. Kohle* **38** (1942) pp. 625-9.

The well-known causes of oil aging are: lack of cleanliness of the machines, admission of air, and high temperature. In addition, aging can be caused by catalytic effects of the metals in contact with the oil. Copper and lead, for example, cause quick aging; tin and aluminum have no influence. The effect of

Three sure things

In 1943 Uncle Sam will need huge quantities of 100-octane gasoline for our fighting flyers, toluene for explosives and synthetic rubber to keep military and essential civilian wheels rolling

We don't know just how much will be needed but these three things we *do* know

1. There is enough petroleum to supply the components of these vital products in enormous volume
2. U.O.P. processes are ready to produce them from that petroleum efficiently and speedily, and those processes are at the service of all refiners under license from Universal
3. U.O.P. know how, built up in a quarter century of experience, is exclusively devoted to helping the refining industry achieve the greatest possible war production—till victory is won

Happy New Year

OIL IS AMMUNITION—USE IT WISELY

Universal Oil Products Co
Chicago, Illinois

Dubbs Cracking Process
Owner and Licensor

THE REFINERS INSTITUTE OF PETROLEUM TECHNOLOGY

With war-time economy and key men being called to the armed forces, man-power is at a premium. More and more plant owners are calling upon us for advice and chemical supervision, and today we are serving eleven times the number of plants we served four years ago. By controlling scale, corrosion, and living organisms, Haering Glucosates definitely improve efficiency, increase production, reduce operating costs, and add years to the life of equipment. Our growth is due to the accomplishment of these results. A smoothly running plant with less outage and waste equipment requires less supervision and fewer men for operation.

If saboteurs in the form of scale, corrosion, and algae are attacking your boilers, steam or water systems feel free to call upon us. Our advisory service is offered without obligation to plant owners. We shall be glad to send sample containers for our study of your water problems.

Write for free booklets.

HAERING WATER CONTROL

WE READ WATER

D. W. HAERING & CO., Inc.

GENERAL OFFICES:

205 West Wacker Drive Chicago, Illinois.

No. 3 OF A SERIES TO HELP YOU KEEP CRACKING STILLS OPERATING AT PEAK EFFICIENCY

CARE IN USING TUBE ROLLING EQUIPMENT

Before rolling a tube into a header or tube sheet, the tube ends and header section should be thoroughly cleaned. No grease or oil should remain on the surface or in the serrations. These elements resist compression and will not permit the proper flow of metal. If this is neglected, heat will ultimately create hard carbon preventing re-rolling and often causing accidents.

The entire rolling tool should also be cleaned frequently in some form of distillate to remove mill scale and other foreign matter. This prevents flaking of the rolls, mandrel and the rolled section of the tube.

AIRETOOL MANUFACTURING CO.

Dept. R, SPRINGFIELD, OHIO

Manufacturers of Tube Cleaners, Tube Expanders and other Refinery specialties.

alloys on the aging of oils was investigated, since alloys are commonly used for journal bearings. Experiments were made on various metals and their alloys, and it was found that alloys containing lead-copper-tin can be used, if they possess globular structure. The aging of oil under the influence of metals or alloys is explained by the formation of local primary cells causing corrosion and the formation of dissolved metal compounds that are transformed in metal soaps by means of carboxylic acids. The soaps accelerate the oxidation of the oil.

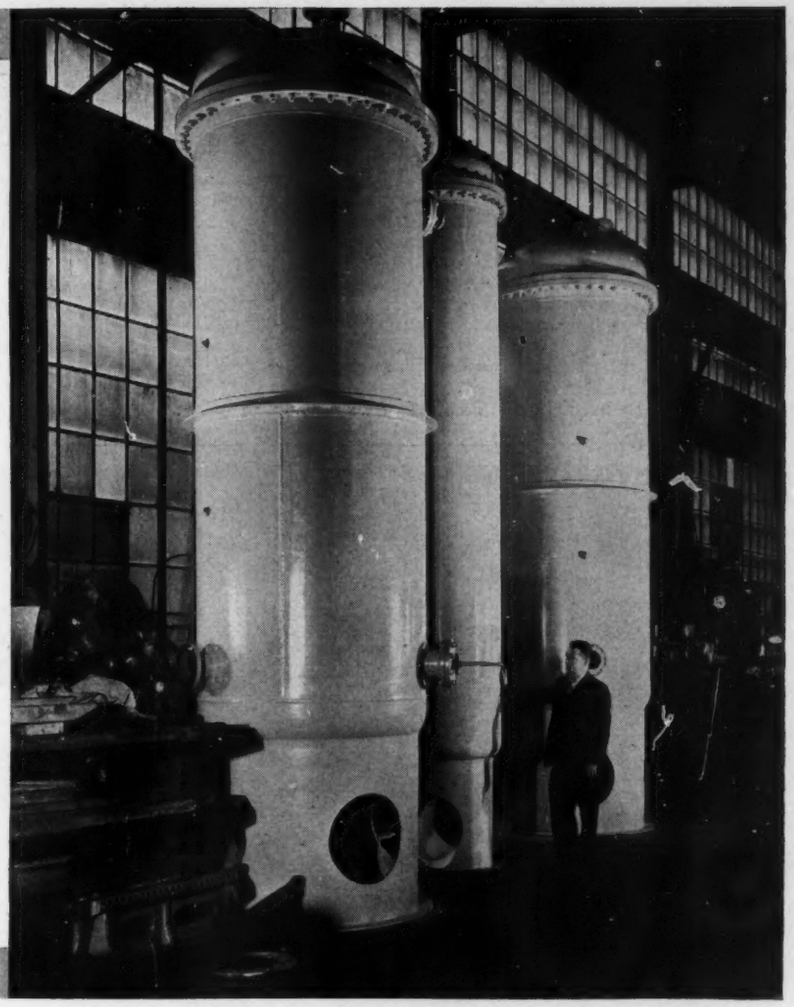
Butyl Rubber Properties and Compounding, J. P. HAWORTH AND F. P. BALDWIN, *Ind. & Eng. Chem.* **34** (1942) pp. 1301-8.

Butyl rubber vulcanizates are unusually resistant to oxygen bomb and air bomb aging, even in the presence of materials that actively catalyze the deterioration of natural rubber. Butyl rubber is highly resistant to attack by acid, alkalies, and ozone. Although readily swollen by petroleum hydrocarbons, Butyl rubber compounds are resistant to many animal and vegetable oils. Butyl rubber vulcanizates are highly impermeable to gases. Compounding data are given for Butyl rubbers differing in molecular weight and degree of unsaturation. As Butyl rubber does not normally undergo much breakdown during milling, the ease of processing is to a considerable extent determined by the original molecular weight. Butyl rubber is much slower curing than natural rubber, but the rate of cure can be greatly accelerated by increasing the unsaturation without carrying this to a point where it seriously affects the chemical resistance of the finished vulcanizate. In general, sulfur vulcanization requires active acceleration—e.g., by tetramethylthiuram disulfide. Of the pigments studied the most useful are the semi-reinforcing furnace blacks and the larger particle size channel blacks. Incorporation of elasticators, such as aromatic ethers, improves hysteresis properties and processability. Butyl rubber can be readily handled on rubber factory equipment. In addition to such specialty uses where advantage can be taken of its exceptional chemical stability, butyl rubber can be employed as a serviceable replacement for rubber in many applications, including mechanical goods, tires, and inner tubes.

Effect of Petroleum Products on Neoprene Vulcanizates, D. F. FRASER, *Ind. & Eng. Chem.* **34** (1942) pp. 1298-1300.

The use of the aniline point has been advocated as a means of predicting the swelling power of lubricating and hydraulic oils on synthetic rubber vulcanizates. This procedure allows a means of describing constant-swelling effect oils for specification purposes and has been used to this end. However, in the case of petroleum products, such as kerosene or fuel oil, it has been found that the aniline point alone is not indicative of the swelling effect. However, as is shown in the paper, the aniline point combined with the gravity, in the form of the Diesel index, will predict the swelling effect, and thus can be used to specify standard immersion media of the kerosene type. This allows the replacement of the kerosene-benzene blends by

"ONE TINY PART of the SYNTHETIC RUBBER INDUSTRY"



Charged with Activated Alumina for efficient, dependable drying, these Lectrodryers are on their way to a synthetic rubber plant.

This comment about these huge Lectrodryers—"one tiny part . . . "—compares them to the gigantic new synthetic rubber plants. Actually, these machines loom big in importance because drying is a vital step to our new source of rubber.

Vitally important, too, is the dependability and high efficiency of the drying agent with which these machines are charged. Alorco Activated* Alumina does its drying job well, no matter what the assignment; drying liquids, air, or gases to dew points below –110° F. And Activated Alumina removes acids from oils and other liquids.

When Activated Alumina becomes laden with moisture, it is reactivated by heating and restored to its original high efficiency.

Alorco Activated Alumina is providing dependable drying service on all kinds of war work; increasing yields and recoveries; maintaining constant quality; eliminating corrosion and assuring continuous performance of equipment.

ALUMINUM COMPANY OF AMERICA (*Sales Agent for* Aluminum Ore Company) 1963 Gulf Building, Pittsburgh, Pennsylvania.

*Registered trade mark

"ALORCO" ALORCO Reg. U.S. Pat. Off. PRODUCTS

ACTIVATED ALUMINAS

constant swelling effect kerosenes that will permit the use of higher test temperatures and will eliminate the necessity of reflux condensers during immersion tests.

Determination of Unsaturates in Hydrocarbon Gases, R. F. ROBEY AND C. E. MORRELL, *Ind. & Eng. Chem.*, Anal. Ed. **14** (1942) pp. 880-3.

Introduction of processes for polymerization, alkylation, and the production of synthetic rubber raw materials, which involve olefinic compounds, have demanded higher accuracy in the analysis for these substances. A method for determining unsaturated hydrocarbons in gaseous hydrocarbon mixtures by catalytic hydrogenation has been described by McMillan, Cole and Ritchie. The authors believe that the method is satisfactory from the chemical standpoint, since hydrogenation is complete, free of side reactions, and sufficiently rapid for routine use. However, the method is based on the assumption that the lower hydrocarbons are ideal gases. These compounds actually deviate considerably from the ideal gas laws. The nature of these deviations was investigated. The compressibilities of the lower paraffins, olefins, and acetylenes are given in a table. Correction charts are presented for the hydrogenation of ethane-ethylene fraction or acetylene, for hydrogenation of propane-propylene-propadiene fraction, and for hydrogenation of butane-butylene-butadiene fraction, and for the hydrogenation of pentane-pentene, pentadiene fraction. The results of various typical analyses of known gaseous mixtures are given.

Let this be your Stock Room of

PRINTED FORMS

Oil Company Reporting and Accounting Forms Carried in Stock for Immediate Use.

Eliminate loss of time by having available stock forms for immediate use without waiting for special forms to be printed.

Buy only in quantities as needed at mass production prices.

Be sure of the same spacing and style of type on succeeding orders of forms used.

We will wrap and mail to your field offices, without additional cost for postage or handling.

If you do not have a copy of our **Fully Illustrated Catalog,** call or write us.

THE GULF PUBLISHING COMPANY

3301 Buffalo Drive – HOUSTON, TEXAS – P. O. Box 2608 – Phone Hadley 3141

Complete stock of these forms are available in: CORPUS CHRISTI from Jack Bonner Company. MIDLAND from West Texas Office Supply Co. SAN ANTONIO from Paul Anderson Company. TULSA from Johnson Printing Company, P. O. Box 1725.

A Tilting Arc Flow Divider Suitable for Reflux Ratio Control, S. PALKIN AND S. A. HALL, *Ind. & Eng. Chem.*, Anal. Ed. **14** (1942) pp. 901-2.

The reflux divider described in the paper is of the continuously dividing type. It has the advantage that ratio control is reasonably independent of rate, and is not subject to difficulties arising through contact of distillate with the lubricant of a stopcock. The device has a negligible hold-up, and is relatively simple in construction. Its design is based on the observation that when a stream of liquid is delivered to some point of an arc there results a division of the incident stream into two streams that fall from the extreme ends of the arc. The relative volumes of the two streams depend upon the point of the arc where the liquid is dropped, and the angle or tilt of the arc. Best results were obtained when the liquid was delivered to the center of the arc, and the flow division was determined by the angle or tilt. The device used is illustrated, and data are given covering its use in the control of reflux to a fractionating column.

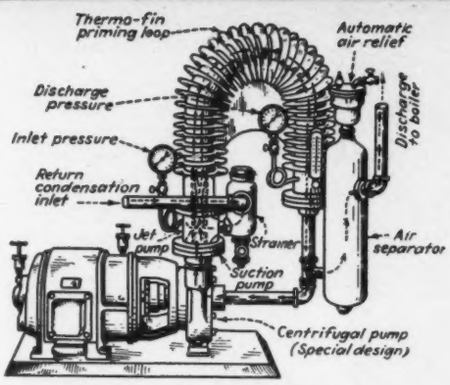
Spring Tension Balance for C.F.R. Bouncing Pin, P. DRAPER, *Jour. Inst. Petr.* **28** (1942) pp. 209-13.

An instrument was designed in 1939 by D. M. Clement, of the Shell Laboratory in London, for accurately determining the tension of the leaf-springs and plunger-spring on the C.F.R. adjustable-leaf-type bouncing-pin. The standard instructions for setting were found to be inadequate, particularly when testing high-octane fuels. After consideration by the Sub-commitee of the Institute of Petroleum detailed alterations were made. The final apparatus proved so successful that it has been employed for some time in almost every C.F.R. installation in the United Kingdom, and in many laboratories overseas. The apparatus and its use are described in some detail.

Effect of Altitude on Knock Rating on CFR Engines, D. B. BROOKS, *J. Res. Natl. Bur. Standards* **28** (1942) pp. 713-34 (Res. Paper No. 1475).

Ratings of gasoline for high altitudes do not agree with ratings made at sea-level laboratories using the 1933 ASTM Motor Method. The corrective procedure used included the use of a series of Venturi tubes to correct for altitude by maintaining constant compression pressure, although this did not result in maintaining constant knock intensity. New tests have been made using the CFR engine in the altitude chamber, with results checked by field tests. The effect of altitude on knock ratings can be avoided by operating at constant knock intensity. Micrometer settings for standard knock intensities for octane numbers from 40 to 100 for the ASTM Motor Method and for the CFR Research Method are given for various compression ratios and for several Venturi tubes.

C-B *High-Pressure* CONDENSATE RETURN SYSTEM
for REBOILER CONDENSATE DRAINAGE



EXCLUSIVE JET PUMP DESIGN

OPERATES IN A CLOSED CIRCUIT

MAINTAINS PRESSURE DIFFERENTIAL across process equipment, with discharge of condensate against higher pressures without FLASH LOSS or necessity for high static suction head—flash tank—float control or auxiliary pump

INCREASES EFFICIENCY—assures constant evacuation of condensate and entrained air from equipment—maintains maximum, uniform heat transfer rates

LOWERS STEAM COSTS—by direct return of hot condensate to waste heat boiler—surge tank or pressure return line to boiler plant.

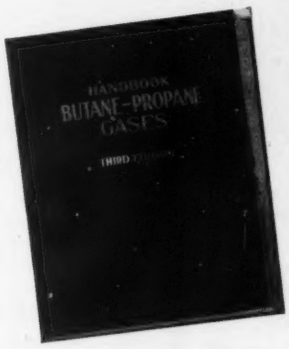
AUTOMATIC IN OPERATION

SUBMIT PROBLEMS without obligation—Ask for Publ. #3025

COCHRANE CORPORATION
3115 N. 17th STREET PHILADELPHIA, PA.

ENTIRELY NEW
COMPLETELY
REWRITTEN

3rd EDITION



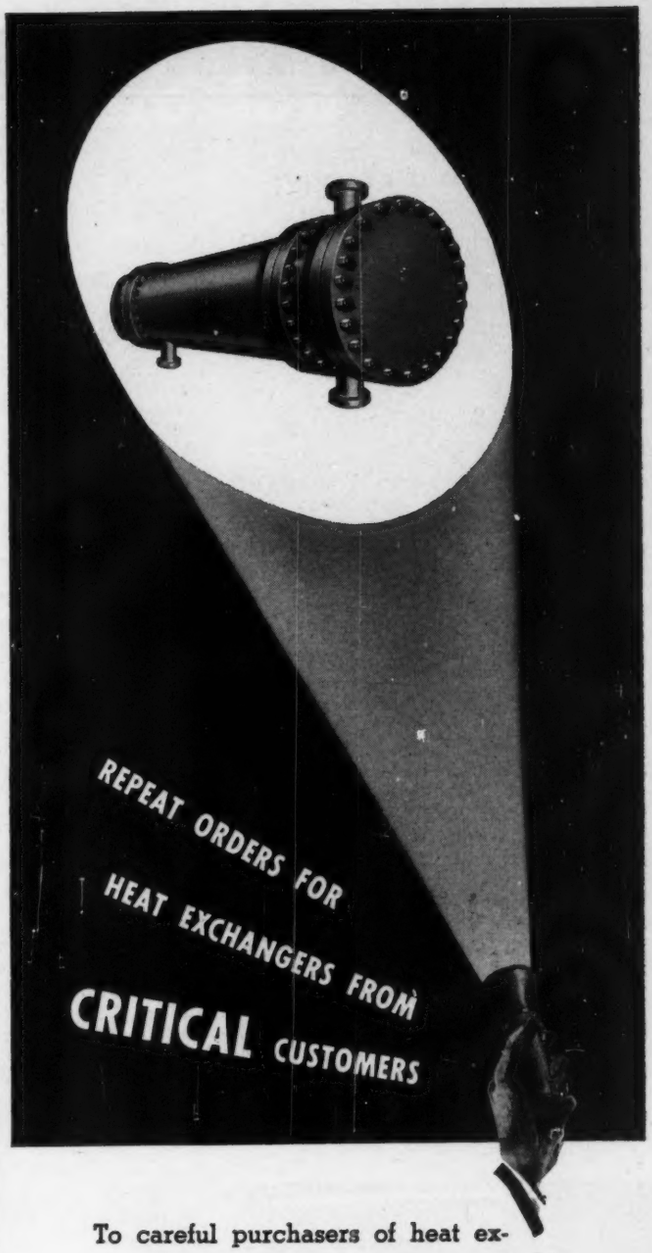
HANDBOOK BUTANE-PROPANE GASES

The Only Complete and Authoritative Reference Book on LP-Gas Engineering, Installation and Operating Methods

CHECK THESE CONTENTS: The Progress of the Industry. The ABC of LP-Gas. Properties of the Hydrocarbons in LP-Gas. Properties of Butane-Propane Mixtures. Volume Correction Factors. Analytical Determination and Testing. Fire Protection and Control. Production of LP-Gas. Delivery by Truck, Rail, Water and Pipe Line. Storage Tank and Pressure Vessel Design. Liquid Metering and Pumping Systems. Installing and Servicing LP-Gas Systems. Semi-Bulk Systems. Bottled Gas Systems. Gas Utility Service from Central Plants. Multiple Utility Service from a Central Plant. Comparative Performance with Other Fuels. Appliance Installation and Testing. Domestic Applications. Commercial Applications. Industrial Applications. Enrichment, Peak Load, and Standby Uses. A Fuel for Internal Combustion Engines. N. B. F. U. Pamphlet No. 58. Motor Carrier Regulations. Railroad Freight Regulations. Unloading from Railroad Tank Cars. Marine Regulations. Products Liability Insurance. Handy Tables for Field Use. Bibliography. Buyers' Guide. Glossary of Terms. Equipment and Appliance Catalogs.

$5.00 Send Check or Money Order to *BOOK DEPARTMENT* **$5.00**

THE GULF PUBLISHING COMPANY
P. O. Drawer 2608, Houston, Texas



To careful purchasers of heat exchange equipment, N·R·C means QUALITY WORKMANSHIP. Every customer has been a repeat customer because of the high standards of N·R·C design, construction and service.

INDUSTRIAL DIVISION
THE NATIONAL RADIATOR COMPANY
221 Central Avenue, Johnstown, Penna.

NAME.....

ADDRESS.....

CITY.....STATE.....

NEW EQUIPMENT FOR THE MODERN PLANT

Welding Cables

NATIONAL CYLINDER GAS COMPANY

National Cylinder Gas Company, Chicago, has announced new solderless connectors and lugs for welding cables. Ease and speed of shop or field installation, complete safety, full protection of cables, and the conservation of vital materials are the principal advantages claimed for the new Cable-Tite connectors and lugs.

The body of standard Cable-Tite connectors is one piece. The "quick" models, recommended for use where the whip-end and main cables connect, have a two-piece body. A slight twist while connecting locks the body into one unit.

Soldering is eliminated—saving material, labor and time. To install a Cable-Tite in the shop takes but two or three minutes; in the field takes only five minutes.

Compression collar grips the cable-end and shapes it into a head which cannot work out or be pulled out of the fitting.

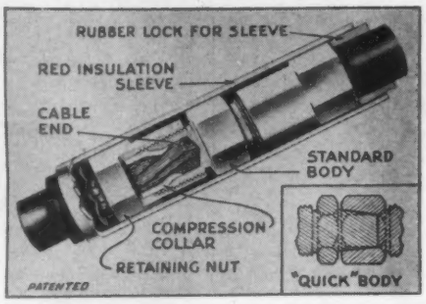
The conductivity of a Cable-Tite fitting is greater than the cable, resulting in cool operation and increased life for the cable.

Fittings are ruggedly built to stand rough use. Outlasts cable, may be used again and again simply by replacing compression ring when being installed on a new cable length.

After initial installation, cable lengths may be connected or disconnected by hand. Nut swivels so that cable is not twisted.

Heavy-duty insulation sleeve, held by soft rubber locks, assures safe operation and entirely eliminates taping.

Insulating sleeve is bright red in color — makes Cable-Tite connectors easy to locate.



Ease of connecting and disconnecting makes it practical to switch cable lengths periodically so that wear is uniform, thereby increasing cable life.

Welding Lamp

RADIANT LAMP CORPORATION

Radiant Lamp Corporation, Newark, New Jersey, has introduced a new type spatter-proof lamp for welding and rough industrial use. The new lamp, known as the Radiant Spatterproof Lamp, is made of a special glass that resists penetration of hot metal particles, and it is built to withstand severe handling.

By reducing lamp replacements, Radiant Spatterproof Lamps not only save money but increase the worker's production. Spatterproof lamps have a T10 bulb with medium screw base. Sizes include 50, 75, 100 and 150 watts.

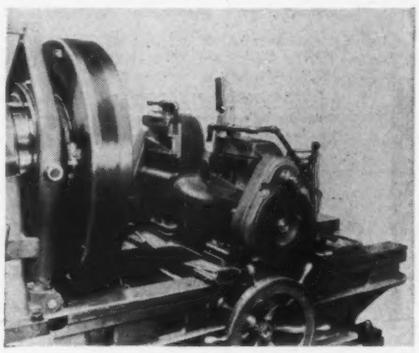
A new 200-watt lamp which is guaranteed not to crack due to climatic conditions, even when used outdoors in an open fixture, has been added to the company's line of weatherproof lamps for general lighting service. The complete range is now from 200 to 2000 watts inclusive.

Cutting Unit

LANDIS MACHINE COMPANY

The Landis Machine Company, Waynesboro, Pennsylvania, has recently developed a hydraulically controlled cutting off unit. This device replaces the standard carriage, crossrail, and die head of the Landis mill type pipe threading machines where these machines are to be used strictly for the cutting off operation and when maximum operating efficiency is desired.

The Landis hydraulically controlled cutting off device comprises two high speed steel cutting-off tools mounted in massive slides for maximum rigidity. These tool slides function through a hydraulic cycle which provides rapid traverse of the tools to the work and rapid retract of the tools after the cutting-off operation is completed. A single lever controls both the forward and return movements of the tool slide.



Landis Cutting Unit

Complete operator control of the hydraulic cycle provides variable feed rates for the cutting off tools and adjustment of the length of travel of these tools for different thicknesses of tubing. The adjustment for rate of feed is made through a single control valve so that the rate of feed, for both the front and rear cutting-off tools will be the same.

Electron Microscope

GENERAL ELECTRIC COMPANY

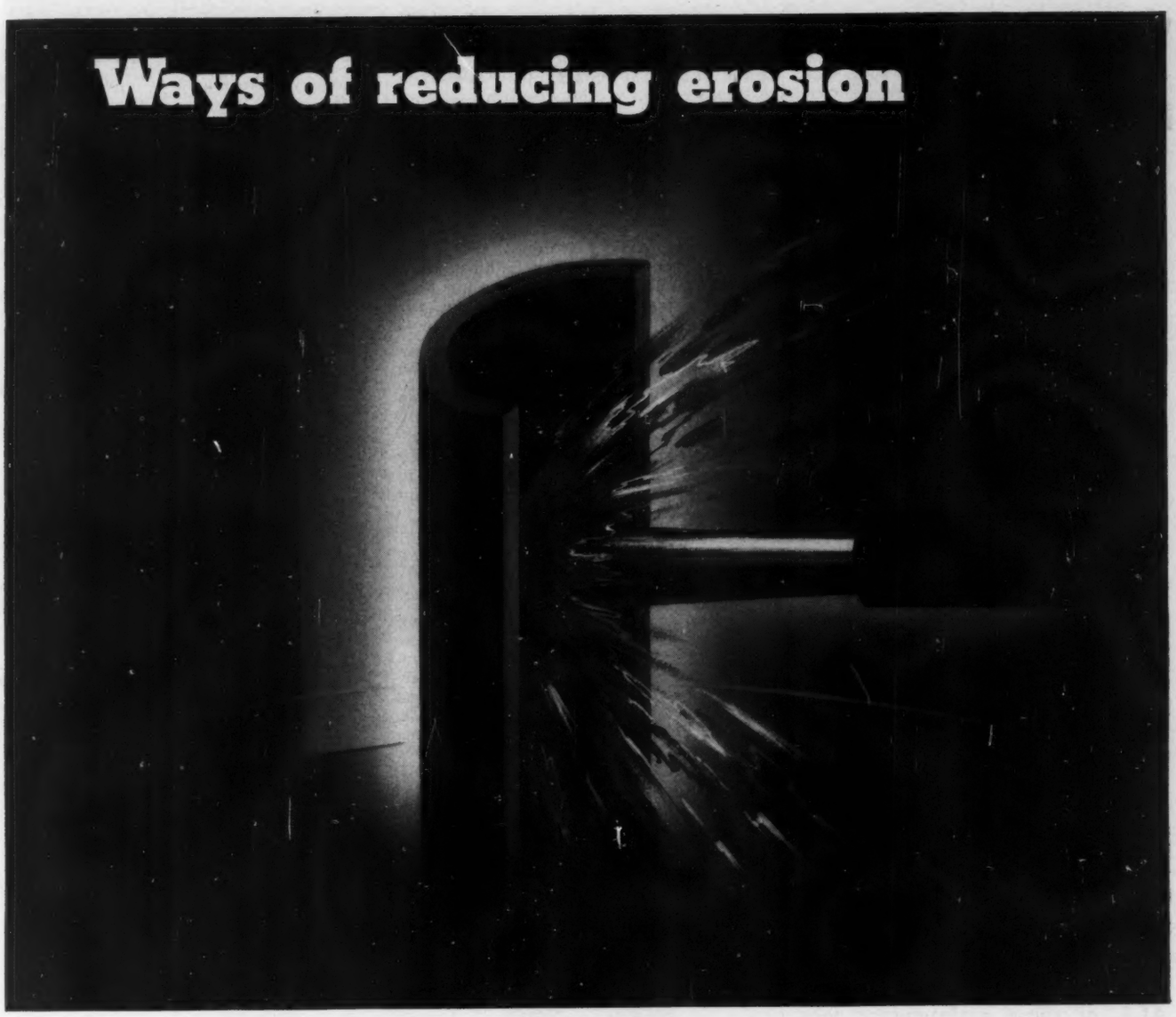
General Electric Company, 570 Lexington Avenue, New York, has announced development of a new electron microscope, which can measure particles as small as one-millionth of an inch. The new microscope and its operation were explained by Dr. C. H. Bachman of the G-E electronics laboratory at a meeting of a section of the American Institute of Electrical Engineers in Lynn, Massachusetts.

This is made possible, according to Dr. Bachman, by the use of a new type electron optical system which maintains a "fixed" magnification regardless of voltage variations; previous electron microscopes have suffered in this respect because their magnification varied with the applied voltage.

"With the new G-E electron microscope, small cubical shaped smoke particles only one millionth of an inch, for example, can be clearly seen," he explained.

"In the new instrument, a specimen can be enlarged 10,000 times. Further

Ways of reducing erosion



Information supplied by "Petroleum Refiner"

Erosion is one of the enemies of metals. Violent impingement of high-velocity fluids against metal surfaces, or the grinding action of moving abrasive particles, causes erosion. Eventually this eats away enough metal to affect safety and operation.

In one refinery a high-velocity oil stream containing bits of hard coke was striking directly against the inner wall of a receiving vessel and rapidly thinning the metal. This action was stopped by interposing a flat steel plate between the vessel wall and the oil stream. Introducing oil into vessels through pipes with outlets curving along the wall, thus allowing the discharging stream to follow the wall periphery rather than strike against it will also stop erosion.

In another instance oil carrying gritty matter was wearing away a pipe where a sharp bend occurred. The bend was replaced by a curved section around which the oil flowed smoothly and with markedly reduced erosive action.

Sand carried up in water taken from wells may seriously erode pumps. One form of protection is the installation of a horizontal settling drum between the well and the pumps. Sand settles out and is periodically flushed from the drum.

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.
MOLYBDIC OXIDE BRIQUETTES • FERROMOLYBDENUM • "CALCIUM MOLYBDATE"

Climax Molybdenum Company
500 Fifth Avenue • New York City

MOLY

YOU CAN DO THESE 8 JOBS EASIER and FASTER the low-cost Oakite way!

1. De-scaling Diesel and gas engine cooling systems
2. Cleaning tank car interiors
3. Salvaging valves and fittings
4. Cleaning absorption towers
5. Reconditioning oil drums
6. Cleaning heat exchangers
7. Washing pumping station floors
8. Removing lime-scale deposits from refrigerating equipment

When you handle each ONE or ALL of these maintenance jobs the effective, economical Oakite way, you will find you can do the work EASIER . . . also in LESS TIME! This is because Oakite materials and methods are specially designed for a specific type of work. As a result, you conserve valuable man-hours, reduce equipment down-time, increase operating efficiency, and save money!

Booklets and Data Sheets FREE!

Try specialized, safe, fast-working Oakite materials and methods . . . prove these facts for yourself. Write today for FREE booklets, manuals and data sheets giving complete details.

OAKITE PRODUCTS, INC.
50B THAMES STREET, NEW YORK, N. Y.
Technical Service Representatives Located in All Principal Cities of the United States and Canada

OAKITE CERTIFIED CLEANING
MATERIALS METHODS SERVICE

enlargement of the picture can be made photographically, up to 100,000 times the size of the original specimen, or better. Thus the total enlargement employed depends on how the resulting picture is to be used. If, for example, a picture is to be shown to an audience a larger print is necessary than would be employed in a book. What counts is the resolution, or sharpness, of the picture. The magnification is only a matter of choice or convenience.

"The measure of a microscope," Dr. Bachman explained, "lies in how small an object can be seen, rather than how much an image can be magnified, for magnification alone does not make a picture clearer."

If a human hair, about 1/100 of an inch across, were split lengthwise into 100 slivers, and 99 of these pieces were thrown away and the one remaining piece was split again into 100 similar pieces, each of these filaments only 1/1,000,000 of an inch across would stand out clearly in the G-E electron microscope.

Rotary Pump

BLACKMER PUMP COMPANY

Blackmer Pump Company, Grand Rapids, Michigan, has designed a new vertically mounted rotary pump, which is powered by a 15-horsepower gearhead motor. Although most of these units are now going into marine service, the small space requirement for mounting gives these pumps an adaptation to industrial use where oils and other nonabrasive liquids are to be transferred.

Blackmer Pump

General specifications of these pumps are: capacity, 100 gpm at a pressure of 100 psi when handling diesel fuel; all bronze construction; motor standard gearhead type; speed, 17,700 rpm, reducing to 550 on the drive shaft; base is fabricated steel, designed for bottom and back anchorage in mounting.

Liquid Level Control

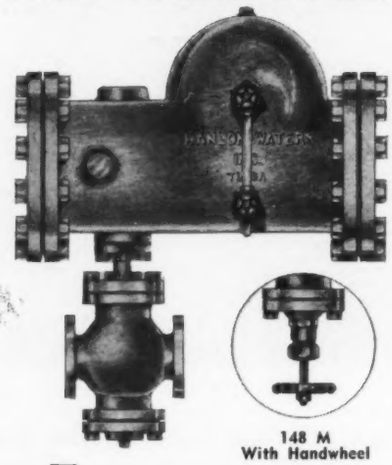
MOORE PRODUCTS COMPANY

Moore Products Company, Philadelphia, has announced a completely rubber- or neoprene-covered liquid-level controller for installation in a standard rubber-covered tee fitting, or for direct mounting in a tank containing corrosive fluids.

Rubber-covered-steel flexible shaft eliminates packing glands and bearings and also provides a simple friction-free method of transmitting the float motion to an air pilot valve or micro-switch as required.

The flexible shaft consists of a formed tube similar to a Bourdon. A flat lever inside this tube connects directly with

H-W
Type 148 Drainer
and Liquid Level Control
Designed for use with HIGHLY CORROSIVE FLUIDS



148 M
With Handwheel

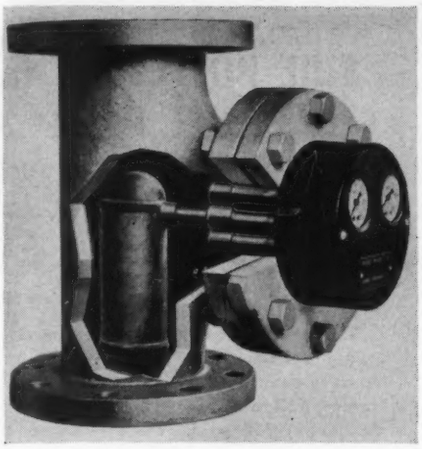
THE TYPE 148 H-W Drainer and Level Control is especially designed to meet requirements of the Power and Refining Industry for service as condensate drainer on preheaters, condensers and heating systems. Since NO stuffing boxes are used, this control is ideal for service with highly corrosive fluids, as well as other level control requirements where stuffing box friction would be objectionable. Balanced valve makes possible use on high working pressures.

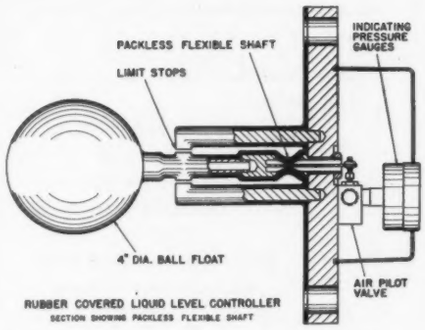
NO STUFFING BOX . . . . . FRICTION

Flanged body ends simplifies accessibility to the float and inner working parts without necessity of dismantling piping. Construction follows ASA flange ratings for working pressure and temperature. Ring-Joint flanged body design also available.

Information on all HANLON-WATERS Equipment available at representative nearest you

HANLON-WATERS, INC.
TULSA, OKLAHOMA
New York, Chicago, Pittsburgh, Philadelphia, St. Louis, Denver, Los Angeles; Shreveport, La.; Fort Worth, Houston, Corpus Christi and Odessa, Texas





the air pilot valve or micro-switch for controlling the liquid level.

Operating on the principle of force change due to buoyancy, rather than a float riding on a moving level, sensitivity is such that a buoyancy change of less than 8 ounces will result in full travel of the diaphragm operated control valve. This permits the use of a small 4-inch diameter ball float and short float arm approximately 5½ inches in length. Interface level control of liquids having a specific gravity difference as small as .050 can be obtained by using larger floats and longer float arms.

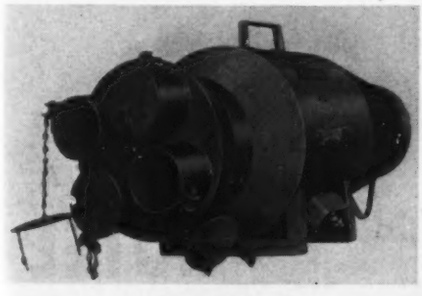
Elliptical steel floats having ⅛-inch rubber covering are used where wider level changes are desirable. For high and low level cut-off or alarm, a micro-switch can be furnished.

Portable Blower

CHELSEA FAN & BLOWER COMPANY

Chelsea Fan & Blower Company, 1206 Grove Street, Irvington, New Jersey, has designed a small portable blower for use in eliminating gas and fumes in welding rooms, vaults and basements.

The unit Octopus, Jr., is driven by a three-quarter-horsepower motor, delivers 2000 cubic feet of air per minute, operates in any position and weighs but 70 pounds. It has adapters for three 4-inch nozzles or four 3-inch nozzles.



Chelsea Blower

War Plant Umbrellas

WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY

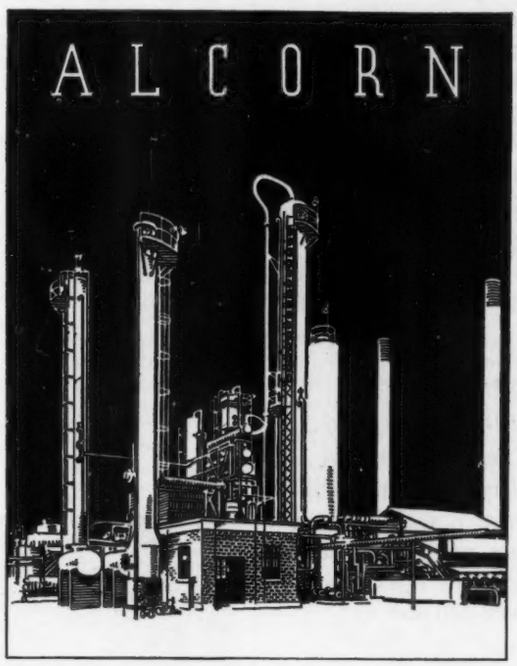
Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania, has announced development of a wire "umbrella" to shield vital explosives plants and oil storage centers from lightning.

It is already being used by some war industries and one huge ordnance plant. Using a minimum of strategic materials, the shield deflects lightning driving earthward at more than 11 million miles a minute.

The shield consists simply of a steel wire strung above the building to be protected and anchored on tall wood poles at each end. The wire is then connected to steel rods buried in the ground.

This method saves copper for other war uses. Previously explosives plants or oil depots were guarded by lightning rods which required about 250 pounds of copper attached to the building and buried in the surrounding ground. An umbrella for the same building can be erected with only 60 pounds of steel and two wood poles. With the new design danger of lightning leaping to metal sections of the building and causing sparks has been eliminated.

Studies of lightning strokes on power lines show that each square mile of sky hurls about 10 thunderbolts at the ground each year. Modern ordnance plants have several hundred buildings spread over a large area so each plant will be a target for lightning several



ACCENT IS ON SPEED
EQUALLY ESSENTIAL IS...QUALITY

THE refinements and complications of modern mechanism—for peace or war—make it essential that products be of a known and constant quality. In no other single point in processing is such constant quality so definitely determined as in your heater—it is the heart of your whole operation. Alcorn has eighteen years' heater experience available to you.

ALCORN COMBUSTION COMPANY
SCHAFF BLDG., PHILADELPHIA
LOS ANGELES HOUSTON SAN FRANCISCO

"Saved from the scrap heap by SMOOTH-ON" is the story that could be told by many an engineer about one or more important pieces of equipment in his plant. Condensers, pumps, heaters, evaporators, engines, compressors, valves and process apparatus . . . wherever a crack occurs in the shell or casing of these and similar types of machines, a SMOOTH-ON repair is speedy, simple, effective, and lasting.

SMOOTH-ON applications require no heat, special tools, or dismantling of apparatus, and the expansive property of SMOOTH-ON wedges it tightly against the confining surfaces of the crack, making a lastingly tight seal.

Today, when replacement of apparatus is difficult or impossible, and when lengthy repairs mean loss of valuable production time, SMOOTH-ON is more a plant necessity than ever before.

Get Smooth-On in 7-oz., 1-lb. and 5-lb. cans or 25-lb., 100-lb. kegs from your supply house, or if necessary from us. *For your protection, insist on Smooth-On, used by engineers and repair men since 1895.*

40-Page Repair Handbook . . . . FREE

40 Pages, 170 Diagrams, simple practical instructions for ingenious repairs to plant equipment, pipe lines, structures. Based on experiences of engineers all over the country. To obtain your FREE copy, just fill in and mail the coupon.

SMOOTH-ON MFG. CO., Dept. 11
570 Communipaw Ave., Jersey City, N. J.
Please send SMOOTH-ON HANDBOOK.

Name_____

Address_____

1-43

Do it with
SMOOTH-ON

times a year. Just one of those strokes could cause a disastrous explosion or fire if proper protective devices were lacking.

Another lightning protection plan suggested surrounds the building with six poles 10 feet higher than the roof. Steel wires extending from the top of each pole attract lightning from the area above the structure so that an invisible lightning-proof "blanket" is suspended over the roof. Thunderbolts are drawn to the steel tips of the poles and thence to the ground.

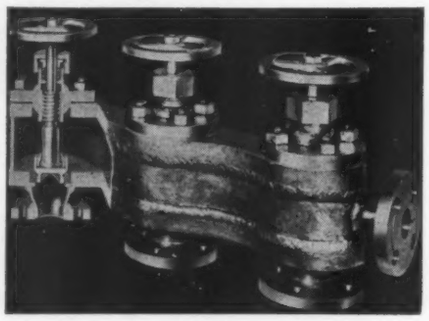
Westinghouse engineers know the character of lightning from data collected in the field by fulchronographs mounted atop fire towers, power lines and radio transmission masts. Lightning striking these structures is led to the fulchronograph which has a constantly revolving wheel. On the rim of the wheel are metal blades which are magnetized by the lightning. The number of blades magnetized and the amount of magnetism in each gives engineers a picture of the thunderbolt.

Welded Valves

ZALLEA BROS. & JOHNSON

Zallea Bros. & Johnson, Wilmington, Delaware, has announced a new welded manifold valve, affording simplification of valve-and-piping hook-ups. Any number of valves of any type in any size, of carbon or stainless steel, chrome iron, nickel, monel or other alloys can be combined in an integrated unit to meet any requirement.

Advantages claimed for welded valves include greater strength with less weight, economy of space, ease of installation, minimum pressure drop and the elimination of bolts, gaskets and flanged fittings between individual valves.

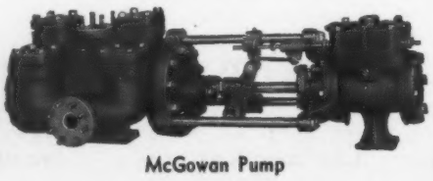


Welded Valves

Volatile Liquid Pump

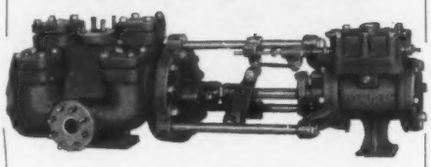
LEYMAN MANUFACTURING CORPORATION

The McGowan Pump Division of Leyman Manufacturing Corporation, Cincinnati, Ohio, has recently added to its line a modern design of close clearance side pot refinery pumps for handling highly volatile liquids. This company, which is active in the chemical and general industrial fields, is currently producing these pumps for the high-octane aviation gasoline and the synthetic-rubber program in 6-, 12-, and



McGowan Pump

SIDE POT CLOSE CLEARANCE PUMP



6, 12, and 18 inch Strokes — Liquid, Steam Cylinder sizes to suit conditions — Designed Pressures in cast iron — 400 p.s.i. suction, 600 p.s.i. discharge, 250 p.s.i. steam — Large Valve Areas — Trim to suit service conditions — Water jacketed stuffing boxes.

Also manufacturers of these type pumps:

SIMPLEX and DUPLEX
STEAM and
POWER DRIVEN
HORIZONTAL and
VERTICAL
FORGED STEEL, CAST STEEL
BRONZE and Various
ALLOYS
VALVE PLATE, SIDE POT
MISCELLANEOUS DESIGNS

McGOWAN PUMPS

LEYMAN MANUFACTURING CORP.
The JOHN H. McGOWAN Co. DIVISION
59 CENTRAL AVE., CINCINNATI, OHIO

Why play blindman's buff?

"Some people waste a whole evening trying to find a 'nice,' 'cheap' place to stay. Not me! I pick out a good hotel and my worries are over. Everything I need is right at my elbow."

J. D. FINDLAY,
Raleigh, N. C.

AMERICAN HOTEL ASSOCIATION

FOR A FRESH START

AMERICAN HOTEL ASSOCIATION AHA

STOP AT A HOTEL

In 1943 it will PAY YOU

to Call- *Vinson* Supply Company

ON THESE PRODUCTS:

FISHER
Automatic Controllers

NATIONAL
Pipe and Steel Tubes

TUBE-TURNS
Tees, Reducers, Flanges
and Welding Caps

CHASE
"Antimonial Admiralty"
Condenser Tubes

Standard Brass Products

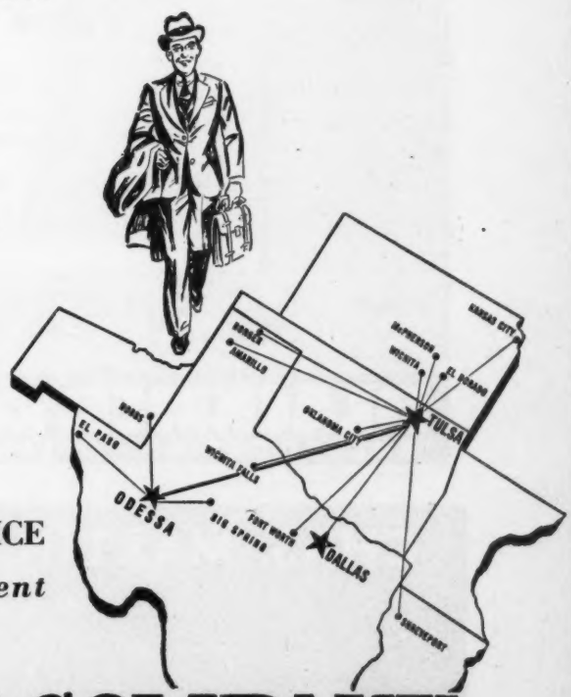
We Also Represent:
OHIO RETURN BENDS
FAHRITE Tube Supports
% PROPORTIONEERS %
COPES
Boiler Feed Water Regulators

IT WILL PAY YOU because of the tremendous resources represented by the manufacturers we represent—each the LEADER in their field.

IT WILL PAY YOU because of the large stocks VINSON SUPPLY COMPANY maintain to meet YOUR immediate needs.

IT WILL PAY YOU because our service organization is made up of trained Engineers, experienced in YOUR problems.

IT WILL PAY YOU as a first step in time saving assistance to put your requirements in our hands, NOW.



"Yes Sir," VINSON SUPPLY COMPANY SERVICE
Covers the Mid-Continent

VINSON SUPPLY COMPANY

DALLAS • TULSA • ODESSA

SERVICE THAT *Merits Your Business*

Call BLACKMER

THE MARK OF A DEPENDABLE PUMP

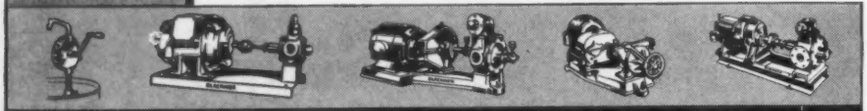
SERVING THE PETROLEUM INDUSTRY FOR 40 YEARS

For capacities up to 700 GPM—pressures up to 300 psi, *Blackmer Rotary Pumps offer these advantages:*

- **Constant volumetric efficiency. No loss of capacity due to internal wear.**
- **Wide range of practical operating temperatures and viscosities.**
- **Self-adjustment for internal wear.**
- **When the "buckets" (swinging vanes) finally wear out, a 20-minute replacement job restores a pump to original capacity.**

Bulletins FREE to ENGINEERS
No. 301—FACTS about ROTARY PUMPS
No. 302—PUMP ENGINEERING DATA

Write Blackmer Pump Company, 2091 Century Avenue, Grand Rapids, Michigan



BLACKMER Rotary PUMPS
"BUCKET DESIGN"—SELF-ADJUSTING FOR WEAR

CHAS. MARTIN & COMPANY
Inspectors of Petroleum
Approved and Licensed by New York Produce Exchange
GAUGING • SAMPLING AND TESTING • TANK STRAPPING
BARGE CALIBRATION • CRUDE CLASSIFICATION • GAS ANALYSIS
1215 Dumble Street, Houston, Texas
Laboratories located at:
Houston, Texas — Corpus Christi, Texas
New Orleans, La. — Jennings, La.
Elizabeth, New Jersey
New York Office: Produce Exchange Annex
Branch offices at all oil ports

18-inch stroke sizes with steam cylinder and liquid-end bores to suit the service conditions.

This design is suitable for 400 pounds suction pressure and 600 pounds discharge pressure in castiron. The steam cylinders are designed for 250 pounds pressure. The valve areas of these pumps are quite large, resulting in low pressure drops through the pumps. Each of these models can be made with a water jacketed stuffing box.

Air-Driven Mixer

MIXING EQUIPMENT COMPANY

Mixing Equipment Company, Rochester, New York, has added three heavy-duty air-driven mixers to its line. Two are gear-reduction models and the third is a larger direct-drive type.

The air-driven motors used in these mixers cannot be overloaded or burned out. Even when used in the heaviest liquids they will not stall. The air exhaust from the motor is so arranged that it keeps the motor running cool at all times.

Air-Driven Mixer

Models of 1 and 1/3 horsepower are available. They are equipped with gear-reduction drive and adjustable shaft length.

TABLE OF SPECIFICATIONS

Specifications	Model AG-33	Model AG-100	Model AR-100
Top Motor Speed	1800	1800	1800
Top Mixer Shaft Speed	400	431	1800
Size of Propeller	8″	12″	5″
Number of Propellers	2	2	2
Max. Shaft Length	60″	60″	48″
Shaft Diameter	⅞″	⅞″	5/8″
Approx. Weight	48 lbs.	50 lbs.	35 lbs.

Shaft and propeller materials: Stainless, plain steel, monel, bronze, etc.

Wooden Tanks

H. K. PORTER COMPANY

H. K. Porter Company, 5024 Harrison Street, Pittsburgh, has added a line of wooden tanks to its processing equipment. These tanks, from cypress, redwood, long leaf yellow pine, fir, oak and poplar, are equipped with the Porter agitating equipment.

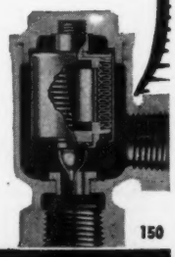
They can be obtained in all shapes and sizes, including cylindrical, rectangular and elliptical, up to 100,000 gallons in capacity.

If it's a Steam Process

SPEED UP WITH SARCO No. 9 Steam Traps

Whenever you see a cluster of Sarco No. 9 Steam Traps you can be sure of several vital features in the equipment they serve.

1. No one steam coil can hold up another. They are all working at top speed.
2. No useful heat is escaping with the condensate. The No. 9 expels only the slightly cooled condensate.
3. There's no trouble starting up. It is wide open when cool.
4. Varying steam pressures will not affect the operation. No seats to change. It's the only thermostatic steam trap made for pressures up to 250 lbs. Catalog No. 250.



150

SARCO SAVES STEAM

SARCO COMPANY, INC.
475 Fifth Avenue, New York, N. Y.
Sarco Canada Ltd., Federal Bldg., Toronto, Ont.

Nowery J. Smith

Manufacturer of

Oil & Gas Separators
API Bolted Tanks, Galvanized and Painted Steel
Oil & Gas Heaters
Welded Production Tanks
Emulsion Treaterators
USS Panelbilt Steel Buildings

Fabricators of Steel Plate and Structural Shapes

NJS

NOWERY J. SMITH SUPPLY CO.
HOUSTON, TEXAS

"You're depending on us..."

"...and we're depending on you!"

We at home are relying on the courage of our fighting men to protect the things we hold dear. But courage alone cannot win battles. Our men are counting on us for a continuous supply of guns, shells, tanks, ships, planes, bombs, food.

Let's not let them down. Let's maintain peak production by avoiding waste, working hard and buying War Bonds!

THE GARLOCK PACKING COMPANY, PALMYRA, NEW YORK
Manufacturers of Garlock Packings, Gaskets and KLOZURE Oil Seals

Tulsa, Okla. Houston, Texas Los Angeles, Calif.

GARLOCK

"The Garand"..

OUR ARMY'S FAMED HIGH POWER RIFLE

Well built, accurate and exceptionally hard hitting! These are the outstanding and highly praised features of the Garand rifle. Used by both Army and Marine troops, these rifles have won great distinction on the field of action.

Hundreds of thousands of Garands have been made in an amazingly short period of time. But for the raw material producers and the factories—and for the men who built them, there had to be an abundance of water. To the Layne Organization fell the task of producing an amazingly high percentage of that water. The quality and dependability of Layne Wells and Pumps had long been proven on the field of action.

Layne Wells and Pumps are backed by more than sixty years of outstanding success in all parts of the world—and even under the most adverse conditions, they constantly maintained their enviable record of highest efficiency and long life. Layne's activity is now nearly 100 percent for the war effort, but when peace returns, installations for municipal and private industries will be resumed. In the meantime, every effort is being made to supply parts and repair service to all existing installations.

For late bulletins, catalogs and further information, address

LAYNE & BOWLER, INC.
Memphis, Tenn.

LAYNE
PUMPS & WELL
WATER SYSTEMS

Affiliated Companies

Layne-Arkansas Company.....Stuttgart, Ark.
Layne-Atlantic Company.....Norfolk, Va.
Layne-Bowler New England Corp...Boston, Mass.
Layne-Central Company.....Memphis, Tenn.
Layne-Northern Company.....Mishawaka, Ind.
Layne-Louisiana Company.....Lake Charles, La.
Louisiana Well Company.....Monroe, La.
Layne-New York Company.....New York City
Layne-Northwest Company.....Milwaukee, Wis.
Layne-Ohio Company.....Columbus, Ohio
Layne-Texas Company.....Houston, Texas.
Layne-Western Company.....Kansas City, Mo.
Layne-Western Co. of Minn.....Minneapolis, Minn.
International Water Supply, Ltd...London, Ont.

WORLD'S LARGEST WATER DEVELOPERS

☆ BUSINESS NOTES ☆

Howard B. Graves Heads Haering Company

Howard B. Graves has been appointed general manager of D. W. Haering and Company, Inc., Chicago.

He joined the company in 1934 as a senior technologist. He was manager of the St. Louis district office.

Manufacturing facilities of the company were taxed to capacity in 1942 and efforts are now being made to increase facilities for this year.

H. B. GRAVES

Key Company Opens District Offices

Key Company, East St. Louis, Illinois, opened its own district offices in the Southwest January 1, 1943.

J. H. Richardson was appointed manager of the Houston office, 1315 Second National Bank building.

The Tulsa office, 533 Mayo building, will be under the direction of M. J. Masel.

Until this change was made the company was represented in the Southwest by Koalt Engineering Company, Tulsa.

B. DeLorenzo Joins Brown Fintube Company

B. DeLorenzo has been appointed manager of the newly created heat-transfer department of Brown Fintube Company, Elyria, Ohio. The company recently announced its entry into the fabrication of complete heat exchanger units for the duration.

B. DeLORENZO

DeLorenzo is a graduate of Massachusetts Institute of Technology in Chemical Engineering in 1930. After two years of graduate study and research he joined Foster Wheeler Corporation as a laboratory technician in 1932, where he specialized in solvent refining. Since 1936 he has been in the design engineering department of Foster Wheeler Corporation, where his work was devoted to heat transfer and flow of fluids.

Awards of Merit for War Time Production

During December, 1942, the following companies were among those to be singled out for awards of the Army-Navy for accomplishments in production.

To the Carrier Corporation, Syracuse, New York, the Army-Navy E with two stars.

To the Crane Packing Company, Chicago, the Navy burgee with a white star.

To The Cooper-Bessemer Corporation, during an inter-plant hookup between Mount Vernon, Ohio, and Grove City, Pennsylvania, presentation of the Maritime M, the victory fleet flag and a Maritime merit badge for each worker.

To the Jessop Steel Company, Washington, Pennsylvania, the Army-Navy E.

To The National Supply Company, Superior Engine Division, Springfield, Ohio, the United States Maritime Commission M.

To A. Shrader's Son, Brooklyn, New York, the Army-Navy E.

To Security Engineering Company, Whittier, California, the United States Maritime Commission M Burgee.

To Distribute Blackmer Pumps

Power Machinery Company, 215 North Detroit Street, Tulsa, has been named sales representatives of Blackmer Pump Company, Grand Rapids, Michigan. The company, headed by Egon Koehler, is an engineering sales organization, which specializes in pumping problems and distributes a general line of machinery and equipment.

It has a branch office in Houston, 2015 Second National Bank building, where F. F. Dietterick is manager.

The service department at Tulsa headquarters is in charge of E. P. Kirchhofer.

Roger W. Allen With Wheelco Instruments

Roger W. Allen has been named Southeastern district manager for Wheelco Instruments Company and will have headquarters in Atlanta. Allen is a native of Atlanta, who attended Massachusetts Institute of Technology and completed his schooling at Georgia Technological Institute.

Recently he has been with The Foxboro Company as district sales engineer at Atlanta.

Abnormal Tension Shortens Belt Life

Conclusive evidence that the life of transmission belting and V-belts is greatly influenced by the tension factor, and that an increase in the tension over that recommended for the belt operation will result in failure of the belt long before it should break down is furnished by data from a series of tests conducted under the supervision of George H. Stewart, belting engineer of The B. F. Goodrich Company, Akron.

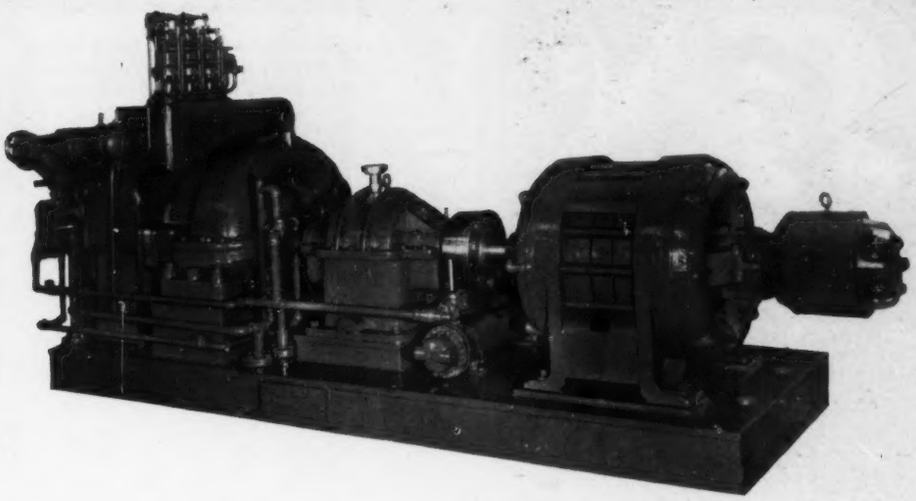
Results of the tests are being released

Refinery Superintendent—Capable of construction and operation of moderate sized plant. Good possibilities of expansion. Remote location. Mechanical knowledge desirable. Give details of training and experience. Box 380, c/o Petroleum Refiner, Houston, Texas.

FOR SALE—Two 250 hp. boilers, two stage air compressors, 75 kw. a.c. generator, ammonia condensers, receivers, pumps, hoists, motors, absorbers, generators, valves and fittings. Complete Dead Weight Gauge Tester, Watt Hour Meter, 125 Volt, 150 Amp. Must dismantle at once. Capital Ice Refrigerating Co., Indianapolis, Ind.

MURRAY

200 K. W. MULTI-STAGE GEARED NON-CONDENSING TURBO-GENERATOR



Unit shown is typical of turbo-generators furnished for non-condensing and condensing service in sizes below 500 K.W. Standard equipment includes oil relay governor with multiple valves, trip and throttle valve, forced lubrication, insulation and lagging, etc.

This unit is in operation at a State Hospital in the middle west, is designed for 175 lbs. initial pressure, 5 lbs. exhaust pressure, 4500/1200 RPM.

MURRAY IRON WORKS COMPANY, Burlington, Iowa

THE CHOICE OF MANY REFINERIES

to meet combustion requirements in the new processes

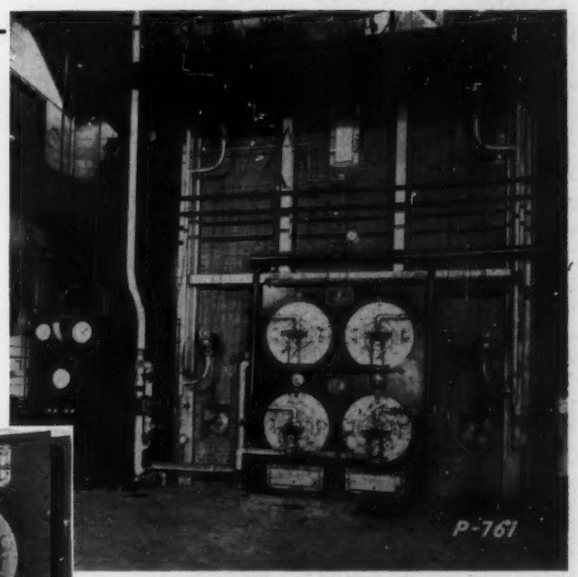
NATIONAL BURNER

NATIONAL AIROIL OIL BURNERS

— • • • —

AIROVENT GAS BURNERS

During the past 30 years in which we have made Fuel Oil Burners, Gas Burners and allied equipment for many of the leading companies in the Petroleum-Chemical Industries, many new conditions resulting from improvements in refinery methods were met and solved. The broad experience gained thereby is enabling us to meet the combustion requirements of new processes rapidly developing because of the urgency of war. Can this experience be of service to you? Call on us.



ABOVE—A National Airoil Burner installation in a large New York refinery of 4 forced draft Universal Combustion Units for burning refinery gas and oil.

LEFT—A Universal Combustion Unit.

NATIONAL AIROIL BURNER

COMPANY, INCORPORATED
1254 East Sedgley Avenue
PHILADELPHIA, PENNA.

OIL BURNERS • GAS BURNERS • GAS PILOTS • PUMP SETS
• EXPLOSION DOORS • ACCESS DOORS • AIR DOORS
• BURNER BLOCKS • FURNACE OBSERVATION WINDOWS

THANKS FOR THE TIP...WE'LL USE PALMETTO PACKING

Ask any user why he prefers Palmetto Packing.

He'll say something like this: "I've tried a lot of packings and I find Palmetto lasts longer, stays soft and never scores a shaft."

Yes, ask a user . . . or better yet try Palmetto yourself.

WRITE FOR LITERATURE

GREENE, TWEED & COMPANY

Bronx Blvd. at 238th St., New York, N.Y.

TWISTED

For valve stems; each strand a perfect piece of lubricated packing.

BRAIDED

For rods and shafts; layer over layer construction insures uniformly even bearing surfaces.

PALMETTO

for steam, hot water, air. PALCO for water. PELRO for oils. CUTNO for alkalis. SUPERCUTNO (blue asbestos) for acids. KLERO for foods.

SELF-LUBRICATING PACKINGS

by the company as another contribution to the rubber conservation program.

Three grades of the present wartime construction of transmission belting were used in that series of tests, which were run at 15 pounds per inch per ply, a 720-pound total for the tension, the recommended figure, and at 18 pounds per inch per ply, a total of 864 pounds tension, on 4-inch pulleys. Belts were all 6 inches wide, 30 feet in length, spliced in 10-foot endless lengths. Tests were all highly accelerated.

Belt No. 1 ran for 95 hours before breakdown while under the 18-pound tension, and increased its life to 230 hours before failure when the 15-pound tension was used.

Belt No. 2 ran for 88 hours at the 18-pound tension, and for 263 hours before failure at 15 pounds.

Belt No. 3 ran for 15 hours under 18-pound tension, and the service life before failure jumped to 48 hours under the 15-pound tension.

Conclusions reached, Engineer Stewart's report says, are that an increase of three pounds per inch per ply over the recommended tension results in the belt giving only approximately one third of its useful service life.

Similar conclusions were drawn from tests conducted on one style of V-belts, used on a popular make washer. The accelerated test consisted of a dead load suspension with the driver sheave 2⅝ outside diameter by ½-inch top by 36 degrees and the driven sheave of 5¼-inch outside diameter by ½-inch top by 40 degrees.

First three belts under tension of 125 pounds center to center, averaged 4½ hours of life before failure.

Second three, under 95-pound tension centers averaged 27.4 hours, while the last three, under 80 pounds, averaged 86 hours.

In giving these tests results, The B. F. Goodrich Company points out that because of their short, highly accelerated nature, they are not an index to life in actual service, and were made only to get data on the ratio of tension to belt life. To have any direct evaluation to real service, tests should be made for much longer periods, the report discloses.

West Coast Office At New Address

The West Coast office of Ohio Seamless Tube Company, Shelby, Ohio, is now at 170 South Beverly Drive, Beverly Hills, California, suite 200.

Irving F. Pohlmeyer is in charge of sales and service in this territory.

Husemann Joins Copperweld Steel

E. W. Husemann has been appointed metallurgist in the metallurgical department of Copperweld Steel Company, Warren, Ohio. He formerly was with Republic Steel Corporation in Chicago.

Head of Refining Company Dies

John Albert Beck, president of Pennsylvania Refining Company, Karns City, Pennsylvania, died December 21. He had been associated with the concern since 1903, when he finished school and joined his father, who was president of the company. Three years later the death of his father brought affairs of the company under his direction.

QUICK TURBINE REPAIRS

If you need dependable Turbine repairs **in a hurry,** call us. We are completely equipped to repair and dynamically balance turbine rotors and any High Speed rotating elements in our modern shops.

25 Years Successful Experience

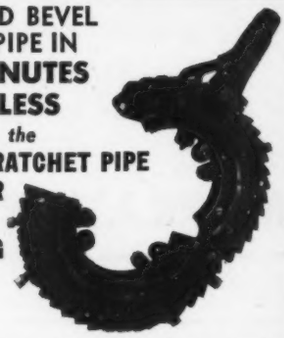
GULF ENGINEERING CO., INC.

"Service, Not Promises"

307 M & M BUILDING HOUSTON, TEXAS

916 S. PETERS STREET NEW ORLEANS, LA.

CUT AND BEVEL YOUR PIPE IN 12 MINUTES OR LESS with the ALSTON RATCHET PIPE CUTTER and BEVELING TOOL



The patented Ratchet Pipe Cutter and Beveling Tool is a sturdy, powerful, easy-to-operate pipe cutter that has been fully tested in the field. Ratchet principle enables operators to work in close places. Bevel tool removes bead on pipe and automatically conditions pipe for welding, threading or sleeving. Cutter may be slipped on or off by simple operation of one pin.

Write for full details on this superior, money saving pipe cutter.

J. I. HILL COMPANY

Exclusive Sales Representative for ALSTON MACHINE SHOP

1011 Shell Bldg., P-9004, Houston

Be 100% with your

★

Buy WAR BONDS